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INTERNATIONAL

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The Port of New York

Commissioner of Docks Hulbert, of New York City, asks for $20,000,000 (£4,210,526) to be spent during the next four years on improving dock facilities. He quotes figures showing that in 1917 there was a gain of only 5 percent in exports from the port of New York, whereas Philadelphia showed an increase of 50 percent, Baltimore 30 percent, Boston 27 percent, etc.

It would be a great help to the port of New York to have the several new docks built for which the commissioner asks an appropriation, but merely to build the docks is not going to help the port of New York materially. With the enormous increases that are taking place, and that are sure to continue to take place during the next three or four years, in the tonnage of American ships and the export trade, New York needs a great deal more than new docks. Indeed, to hold business, it is absolutely necessary that existing docks in every instance possible be equipped with efficient machinery for handling miscellaneous freight, and that any new docks which are built should be so constructed that their prime object shall be simply to house all freight handled largely, if not entirely, by machinery.

Statistics published by the Federal Government in 1912 show that 300,000,000 tons of miscellaneous freight were handled twice at marine terminals during the previous year; that is, the freight had to be delivered at the terminals of origin and hauled away from the terminal of final delivery. Practically all of this freight, indeed it could be said that all of it, was handled by hand and other antiquated and inefficient methods. The best authorities on the subject of freight handling estimate that there is a potential saving of between $30,000,000 (£6,315,789) and $60,000,000 (£12,631,578) in handling this volume of freight. In general terms New York handles half of the marine trade of the country, so that by introducing proper and efficient freight handling machinery at the water terminals in New York there is a potential saving of between $15,000,000 (£3,157,894) and $30,000,000 (£6,315,789).

If New York does not start in at the first possible moment to revamp existing docks and build a large number of new docks that are properly fitted with machinery, the port of New York is sure to continue to handle less and less freight as the years go by and the American merchant marine increases in tonnage.

Technical Contributing

THERE is a great scarcity of technical men who can write interestingly on technical subjects. There always has been such a scarcity. Among the book publishers there is an axiom to the effect that men who have something worth while to write about cannot write about it acceptably, and those who do possess the knack of writing in an interesting manner have nothing about which to write. However true that may be in the field of fiction, if applied to engineering and to engineers it is a sure enough compliment, since a very small percentage of engineers write for publication.

There is great need for technical writers. Information of value to the engineering fraternities should and must be disseminated. Meetings held monthly or yearly among the several societies, while offering opportunities to the members to get up and transmit thoughts and experiences to others, yet these verbal utterances, which in great measure they are, do not offer the possibilities for wide distribution that comes of the written word and the printed page—the technical magazine. Here it is preserved for all time and eternity, since as a means of lasting preservation, the art of writing, as is well known, is second to none.

The editor of Marine Engineering wishes to encourage technical men to try their hand at writing for these pages. The rewards are many besides the one of money compensation. Reputations are made through the medium of continued contributing, such as are possible in no other way. Names become familiar to a wide circle of readers of the better sort, the writer's point of view becomes generally known, his personality is "sensed"—sensed as quickly as though by actual contact—and he one day receives a letter from someone in authority somewhere who wants him to round out the personnel of the establishment—salary the least of things to be considered.

Why not try your hand? However short, anything which you may submit will be given careful consideration.

Annual Meeting of Society of Naval Architects and Marine Engineers

THE twenty-sixth general meeting of the Society of Naval Architects and Marine Engineers, which will be held in Witherspoon Hall, Philadelphia, corner of Walnut and Juniper streets, Thursday and Friday, November 14 and 15, will begin each session promptly at 9:30 A. M. A good attendance is strongly urged—an attendance in keeping with the dignity of the organization. Much interest already has been provoked through the exceptional titles of the papers to be read, a list of which appears on page 657 of this issue, and we believe that, what with the many points of interest held out by Philadelphia alone—Hog Island, to name only one—a meeting of unusual excellence is promised. To this end we ask that each member exert every possible effort to be present at the meeting, and that while there he put forth every exertion to help make this a most successful and enthusiastic get-together. Membership in any organization implies attendance at

meetings as part of the price of initial admission. The Society of Naval Architects and Marine Engineers is no exception. Try to be there.

Need for More Destroyers

SIR ERIC GEDDES, First Lord of the British Admiralty, recently made a strong appeal to America on behalf of his government to expedite the construction of destroyers, anti-submarine craft and appliances of every description with which to further combat the undersea boat menace.

After creating some surprise by quoting Britain's high naval losses, and paying tribute to the United States for her immediate response to war requirements, Sir Eric reviewed the efforts of the United States and Great Britain, both general and naval. Among other things, he said:

"In men-of-war, by which I mean fighting ships of all classes, our losses since the outbreak of the war are approximately 230, more than twice the total losses of war vessels of the other allies. In addition to these losses, we have lost 450 auxiliary craft, such as mine sweepers and trawlers, making a total of 680.

"Turning to merchant ships, our losses since 1914 exceed 2,400 in number, representing a gross tonnage of nearly 7,750,000, being nearly three times the aggregate losses of our allies, and 50 percent more than the total losses of all other allied and neutral countries. We have also whole-heartedly devoted by far the major portion of our shipbuilding capacity to the construction of war vessels to maintain the sea communication of the alliance, to the detriment of our merchant marine."

That Great Britain neglected her merchant marine in order to build battleships was a keen-sighted measure. A merchant marine that was not properly protected would be like a sea-gull with a broken wing—a crippled and practically useless thing.

We in this country have taken the other stand and have constructed far more merchant ships than we have battleships. In so doing, we have held, with our allies, a sort of even keel in a matter of ship production. Yet we must not relax, even though swift events are upon us. Our policy of building up a merchant marine must be continued, even after all hostilities have ceased. Thus we will have proved our loyalty to all those nations associated with us, for it is obvious that our exports after the war will attain to a tonnage never equaled in the history of this country. Yet, as Sir Eric wisely points out, the war as yet is not won, and continued activity, even increased activity, in the construction of destroyers and anti-submarine craft and appliances is of inestimable importance.

10,000,000 Tons Shipping by 1920

A MONTHLY output of 500,000 tons of shipping before the end of this year is the expectation of the Emergency Fleet Corporation. This is one-fourth the tonnage delivered in the thirteen-month period of August, 1917, to August, 1918, both inclusive. If maintained for a year longer, it will mean 6,000,000 tons of shipping added to what has already been turned out, or close to a total of 10,000,000 tons by the end of 1919.

This calls for a tremendous increase in the dry dock facilities for taking care of the tonnage. A report of the United States Shipping Board Port and Harbor Facilities Commission makes recommendation for extensions at ports along the Atlantic and Pacific coasts. The principal extensions as provided for in the Deficiency Appropriation Bill before Congress are as follows:

Porland, Me., one 10,000-ton dry dock, floating repair shop and coaling plant, $2,100,000 (£442,105).

Boston, Mass., bonus for completion of the Commonwealth dock, $250,000 (£54,105); three 10,000-ton floating dry docks, repair shops, coal storage, etc., $6,500,000 (£1,368,421).

Providence, R. I.; Seattle, Wash.; Astoria, Ore., three 3,200-ton marine railways, $760,000 (£160,000).

Fall River, Mass.; New London, Conn., or Providence, R. I., one 10,000-ton dry dock, $2,100,000 (£442,105).

New York harbor, ten dry docks, 10,000 to 20,000-ton capacity, repair and other facilities, $25,000,000 (£5,410,540).

Philadelphia, three 10,000-ton floating dry docks and other facilities, $10,000,000 (£2,105,410).

Baltimore, one 10,000-ton dry dock and other facilities, $2,100,000 (£442,105).

Charleston, S. C., financial assistance for completion of 7,500-ton dock, $300,000 (£63,158).

Norfolk, one 10,000-ton floating dry dock and other facilities, $2,100,000 (£442,105).

Pensacola, Fla., one 5,000-ton floating dry dock, $350,000 (£73,473).

The facilities at New York and Philadelphia are the most important, and work will be rushed on them. They will not be completed for a year or more.

In testimony a few days ago before the House Committee on Appropriations, it was recommended by Charles Piez, vice-president of the Emergency Fleet Corporation, that the Government own the dry docks. He said it was found that private contractors were timid in going into the construction of these plants. The reason for this is that construction costs now are two and one-half times what they are normally. The plan for their building contemplates their continued use for the American merchant marine.

Mr. Piez believes that they will be needed after the war.

"We have always depended," he explained, "upon the other side for repairs because we have had a very small merchant marine ourselves, but with a very much larger tonnage of shipping I think our repairs will probably be made in American ports."

San Francisco Wants to Be Free Port

SAN FRANCISCO, following the example of New York, is making a strong bid for a free port. William Kent, congressman from California, and a member of the United States Tariff Commission, a year ago laid the matter before the San Francisco Chamber of Commerce, and as a result a committee was appointed to investigate the subject and make a report. The report as made is as follows:

First.—It would benefit owners and charterers of ships, and strongly tend to build up a self-sustaining national merchant marine.

Second.—To the merchant, importer or exporter it would be of equal advantage.

Third.—It would simplify and systematize harbor administration. The incoming vessel would be freed from the present exactions of the Custom House regulations.

Fourth.—In customs administrations it would obviate delays due to customs boarding officers; would give prompt docking and uninterrupted discharge of cargo; would obviate heavy bonds to customs against loss by fire, theft, casualty, etc., and incidental delays, and the need of securing permits for early or late hour discharge. Bonded or foreign cargoes could be loaded or unloaded at will; vessels freed of delay from errors in customs papers;

custom officials given due notice of drawback goods. Also, there would be free teams on the docks, etc.

In conclusion, the report emphasizes the desirability of a quick decision by Congress in view of the enormous merchant marine in process of creation.

"The free port arrangement," says the report, "is simply a gigantic harbor facility, and we believe one that can be made most fruitful in its application to our country. It will take much time, labor and money to carry it out, and the period of indispensable preparation should not be postponed longer than is necessary."

October Was Shipbuilding Banner Month

DELIVERY of 400,000 tons of new ships this month is expected by the Shipping Board, following compilation of returns from the yards for the week ending October 18. During that week fourteen wood and steel vessels, with an aggregate tonnage of 77,150, were delivered. This figure, taken in connection with previous construction this month and the reported condition of ships that will be completed before November 1, leads to the expectation of a new monthly record.

Among the feats reported for the week was the completion of the 4,000-ton wood freighter *Aberdeen* at Aberdeen, Wash., in twenty-seven calendar days from the time of launching. Another fast construction was that of the *Invincible*, an 11,800-ton steel freighter, delivered by the Bethlehem Union Shipbuilding Corporation at Alameda, Cal., in 105 calendar days after the laying of the keel.

Requisitioned vessels delivered during the week totaled 30,900 tons, contract steel vessels, 28,250 tons, and wood and composite vessels, 18,000 tons.

The Shipping Board asked Congress for an additional $120,000,000 for the construction of vessels. The Senate Appropriation Committee will consider the request in connection with the Military Deficiency Bill, which is now before it.

An additional $1,650,921 was submitted by Secretary Baker for miscellaneous items, and the Department of Labor asked for $1,000,000 more.

We are making progress rapidly. Yet there lurks the contention in some circles that managerial efficiency is lacking in some shipyards. There may be some truth for this allegation. Certainly it is apparent that some yards turn out more ships per ways than do other yards. A labor handicap or a faulty supply of materials may be the answer. Either cause would reflect upon the management. Materials there are in plenty, and labor may be had if the proper means are exercised toward securing it. This is proved by the fact that some yards have sufficient of both. Then why the big difference in quantitative output between some yards and other yards? There is room for thought here, surely.

Notice Regarding Unauthorized Agents

SOME time ago we gave authorization to a Mr. Frank and a Mr. Fridman to secure subscriptions for Marine Engineering in the Great Lakes district. We have received several complaints from persons in this district, advising us that subscriptions have been given through these agents, and that copies of the magazine have never been received. These agents are not living up to their contract with us, nor are they sending us the names of the men who subscribe through them.

We hereby ask our readers to warn their friends of these two men, and to pay no money to them for subscriptions to Marine Engineering.

Stringerless Ships

UNTIL quite recently it was considered absolutely essential to the stiffening of the side plating of a ship that longitudinal side stringers should be fitted between the bilge brackets and the beam knees. Many vessels are now being built without side stringers, compensation being provided by slightly increasing the depth of the beam knees, these modifications being sufficient to satisfy the rules issued by the classification societies. Many advantages follow the elimination of the side stringers. In the first place, there is a considerable saving in the cost of construction of the vessel; moreover, there is additional cargo space, and the ship is very convenient to discharge, there being no shelves for the lodgment of such cargoes as grain or coal. Further, the increased depth of the bilge brackets either avoids or reduces the unsupported span of the frame between the bilge brackets and the beam knees, which admits of a reduction in the size of frame, so that it is possible to utilize bulb angle frames instead of built-up sections as provided for in former rules. It is open to question, however, whether it is structurally safe to dispense entirely with side stringers, although it is apparent that many builders are at least convinced of the advantages which result from this method of construction.

Much can be said and written on this subject. The shipbuilding world will view with interest the results of experiments along these lines. Ship structures, like all other forms of structure, may be subject to revision.

Marine Wages Are Good

The American merchant marine is the best-paid merchant service in the world. In war or peace, American seamen have always been better paid than those of other countries. After the outbreak of the great war in 1914, the earnings of American merchant marine officers, always liberal, steadily advanced, until they reached the highest level ever known.

The scale adopted by the United States Shipping Board in June, 1918, may be accepted as representative of the wages for officers on American vessels in the second year of America's participation in the war. It is given for illustration only, and in no sense as a guarantee of what an officer may receive on any given type of ship.

The wages paid under this scale on various classes of ships and for various kinds of voyages make too long a list to be presented here. Therefore, to the maximum and minimum only in the scale was added a bonus of 50 percent for voyages through the war zone.

A special bonus, one-half of that paid for service involving voyages through the war zone, was established for ships operating in Atlantic waters, but not to vessels plying exclusively in harbors, bays, rivers and sounds. The scale:

Rating	Pay per Month	With 50% War Bonus
Captain	$230 to $300	$345 to $450
First mate	140 to 165	210 to 247
Second mate	125 to 150	187 to 225
Third mate	110 to 135	165 to 202
Fourth mate	115 and 120	172 and 180
Chief engineer	160 to 230	240 to 345
First assistant engineer	140 to 165	210 to 247
Second assistant engineer	125 to 150	187 to 225
Third assistant engineer	110 to 135	165 to 202
Fourth assistant engineer	115 and 120	172 and 180

Graduates of United States Shipping Board schools serving as junior or sub-junior officers receive $90 a month with no bonus. Not a bad compensation in itself.

The Employment Manager in Our Shipyards

Duties of the General Executive—Importance of Schools—The Wage System and Ideal Service—Psychology of Mass Action

BY EDWARD D. JONES

THE general executive is a correlator. He is a balancer of claim against claim. His business is to define the general aim and to harmonize all lesser or intermediate achievements with it. To do this work well he must be supplemented by specialists who do not correlate or determine general aims or policies, but who concentrate upon some special phase and upon demand furnish to him standards and reliable standardized agencies. The line executive in war determines where a battery shall go and what it shall do, but he depends upon staff men to breed a reliable artillery horse and to design convenient gun carriages and likewise to prepare service tables for sighting guns.

In industry, and this means shipyards as well as other organizations, the function of staff departments is already seen clearly with reference to mechanical equipments. The general executive desires a works; but he depends upon the architect to design building members which will sustain the probable stresses. He desires a product; but he organizes a designing and drafting department to control the dimensions of parts. This principle of staff service is now being carried over into the field of human administration. General executives demand well-chosen men, men physically examined and pronounced safe for the work they are to do, men who, being properly paid and properly handled, may become permanent, contented and loyal cooperators in the general plans of the enterprise. Of all standardized agencies which a service department can put at the disposal of a general executive, the supreme one is a first-class man.

An Extension of the Division of Labor to Foremanizing

The distinction just drawn between line and staff represents a case of the application of the principle of the division of labor to administration. This principle is being applied rather vigorously just now at a lower level in the hierarchy of industrial administration. One of the merits of the movement known as "scientific management" was that it called attention to the absurdly wide range of functions which the average foreman was endeavoring to perform. Until a short while ago this officer was attempting in most establishments to hire men and set their wages and discharge them, to find work for men and machines from hour to hour, to recommend equipment for the shop and keep the equipment in repair, to give an offhand opinion as to when future work would be completed, together with what it would cost to maintain a stock of raw materials, to preserve discipline, and to furnish the office with such records as were required. It is needless to say that the degree of efficiency attained with such supervision was low. "The Jack of all trades is master of none." This quotation found its proof in machinery operated at a low percentage of its possibility, in time lost in hunting tools, in waste of stock, in delayed deliveries, in unreliable quality, and in inefficient, discontented workmen, who frequently vent their grievances in strikes.

The remedy is functionalization. This means that groups of related functions should be put in the charge of service departments, such as the stock room, the planning room, the tool room, the designing department, the pattern loft, the engineer in charge of repairs, and the estimates department. In conformity with this idea there has come into existence in thousands of businesses a department (whether administratively distinct or called by any name suggesting it or not) in charge of the supervision of a considerable portion of the relations between employer and employee.

In this way the foreman is relieved. He no longer is a "bouncer." He no longer sells jobs or practices nepotism or holds his pets in soft places. He has not the easy device of covering his own incompetence by firing a man. Instead, he must suggest a transfer which may show that his employee is able to give satisfaction in another shop where the foremanship is different. He gets a more even and dependable run of workmen from the employment department than he could provide himself. And, being free from other distractions, he becomes the teacher of the shop.

Vocational Guidance

Vocational guidance is a sister movement to vocational education. It has made much progress in connection with the work of the public schools, supplementing as it does parental advice, which no longer is adequate in these days of innumerable trades. It offers to the pupil a new reason for taking interest in his school work—namely, his interest in his own future career.

Vocational guidance has shown us the necessity of analyzing industrial tasks, to find out of what they consist, in what their peculiar difficulties lie and what qualities they demand of the worker. It has shown the need also of studying the mentality of the youth and endeavoring to understand his temperament, so that work may be found for him which accords with his talents, which possesses interest for him and which has power to evoke his enthusiasm.

This experience of the schools in the guidance of youth has caused us suddenly to realize that for most communities the only vocational counselor yet available is the man who does the hiring in factory or yard. So hiring takes on a new significance. It no longer consists merely of the work of giving out jobs; it is, or ought to be, vocational guidance. We demand for this important function skill and specialized experience and a high ideal of responsibility to the person employed.

The Evolution of Psychology

In recent years there has been budded off from philosophy a science of the mind which, adopting the laboratory process and following the conservative methods of inductive research, has accumulated a store of knowledge concerning the nature of the sensory impressions, the character of mental action, and the types of mental imagery. It has done much to aid in classifying the characteristics of personality and to define the various types of temperament. It defines for us various types of arrested development and various classes of unbalanced personalities.

This science now offers us the possibility of selecting from the applicants for jobs at a factory office those per-

sons who are adult in physical devlopment, but still have the minds of children. It identifies the self-centered paranoics and also those bright and optimistic persons who are certain, because of temperamental instability, to endure for a short time only, or to become truoblemakers.

As such persons may comprise from 5 to 15 percent of all applicants, the importance of careful examination is obvious. This identification is not for the purpose of refusing them work, but to give them work which is within their powers, and to provide them with a supervision which is more intimate and constant and forebearing than normal persons require.

Psychology also tells us much of the means of impressing the memory, of holding the attention and of arousing the interest. It explains to us what the learning process is. It pictures the various instincts and their corresponding emotions, so that we can see why there is attraction in matched records and in the idea of a game. In all this it leads up to and elucidates the simple but permanent basis of discipline and loyalty. Indeed, so fertile is this new science in suggestion, we can foresee the time in the near future when the employment manager will be expected to be well grounded in it and to keep himself in close touch with its evolution.

The Evolution of the Wage System

The conviction is general among employers that the setting of a wage rate is perhaps the most vital matter in the relation of employer to employee. The employer needs to have such investigations made as will reveal the current market rates for different types of labor power. He needs an expert to supervise patiently the prolonged process of forming a wage scale in which each job in the shipyard will find its proper relative place. It is coming to be realized that wages can never be made wholly satisfactory until greater definiteness is attained in measuring the basic factors involved in it, such as the worker's talent, the quality and quantity of effort required by the task, and the working conditions. Where low rates of pay are concerned it is essential to obtain the local cost of living by first-hand inquiries. Where excess performance is required it becomes a problem for the expert to say what excess above standard wages is required.

The ideal wage system is that of the man in business for himself. For such a man reward rises and falls in perfect accord with his performance. The endeavor of executives to approximate this wage, in the complexities of modern business, has led to the devising of many kinds of productive bonuses. Where these bonuses are sufficiently localized upon an individual plant and pertain to a sufficiently definite and measurable aspect of performance, and where they are properly founded upon an hourly wage rate and a standard of performance, they have given satisfaction. To plan such bonuses in strict accord with the conditions of the individual industry, the employer needs the services of a competent department.

Safety First

The sense of responsibility felt by the modern employer for his men has led to a movement to cut down the large toll of bruises, burns, infections, mutilations and deaths in industry. This impulse has been supplemented by workmen's compensation laws, which enforce responsibility upon those employers who do not voluntarily assume it. The study of accidents shows that they result for the most part from bad management, from equipment allowed to fall below standard condition, from lack of training, from labor turnover, from lack of physical examinations and lack of job analysis. Above all, they are caused by the absence of a judicious attitude of mind among employees. This fact puts the problem more largely within the domain of the employment manager than of the engineer.

Hygiene, Sanitation and Medical Aid

A great advance has been made in medical science in recent decades. This advance has laid bare the intimate relation between good water, ventilation, digestible food, regularity in private habits, and health in the home on the one side and accident rates, fatigue, irregularity in attendance at work, antagonism of mind, and strikes on the other. The complicated interlacing of these factors accounts for the profitableness of the health work which has been undertaken by progressive employers.

The Democratic Shop

It is needless to refer to the steady drift of industry toward democratic control. This drift may make itself felt to an employer as the mandate of law. It may come as the dictate of organized labor. On the other hand, if it is met with willing mind it may come into an employer's business in the form af a welcome co-operation with his employees, such as getting together to settle questions of common interest or as a process of taking from his shoulders a portion of the load of minor executive responsibilities. Through such a sharing the employer may give to his employees scope for suggestions and criticism, and he may give them a voice in determining working conditions. If he makes these experiments tactfully and sincerely he is altogether likely to find that production is improved, that the best employees seek his plant, and that discipline is largely self-enforced.

There is a wide field of activity having to do with the efficiency of the worker and including such matters as thrift, legal aid, insurance, pensions, housing and recreation, in which the employer will desire that as large a portion of the initiative may come from his employees as possible. The employment manager's task is to guide these activities into fruitful channels in as natural a manner as possible. He may be a sort of power behind the throne, but he should be modest enough to give the credit to others for what has been done, whenever possible.

The Ideal of Service

The ideals of truth and service for many years have been prominent in the world of advertising and selling. Only shortsighted persons still believe that to make a sale terminates a business relation. It is much more in harmony with the best practice to say that a sale begins a mutually profitable relation. Henry Ford once asked his agents to remember that they were not selling machines but selling transportation. If this concept of a service relation be carried into the interpretation of the labor contract, it will be seen that in reality an employer "sells" his job to the employee. He "sells him," or satisfies him, as to the wages, the working conditions, the task to be done, and the policies of labor management in general. Then his problem is to keep him "sold."

But it should not be a mere job that is sold. A permanent relationship should be entered into—a relation of mutual aid and protection. To quote Ford again, "It is not a living but a life we are trying to provide for our workmen." This ideal of service has led American business men to venture out constantly beyond what were once considered to be the boundaries of strict business. The surprise which has usually accompanied such ventures has been their profitableness. Where an employer has had faith, superior employees have gathered to him and built up a permanent and enthusiastic force around him.

The coming of the great war has intensified the strength of all these evolutionary movements. It has done so because the war has made efficiency seem more necessary and because these movements are all calculated to construct a more firmly knitted and economical social order. The present shortage of skill commends to us a stricter labor accounting, both in the labor market at large, at the hands of a public employment service, as well as within the individual business, through the work of an employment department. The same necessity brings us to intensive methods of training skill with careful vocational guidance, so that every man, young or old, may find his highest work. It implies, again, safety, sanitation and medical aid in industry to maintain the working force at par.

Enthusiasm for the common cause of country is a great lesson in the psychology of mass action for industrial leaders who have never learned the power of common cause with their workmen. Wages and prices have passed through such advances as to demand the closest attention to the wage-setting process. The great slogan "To make the world safe for democracy" is certainly being carried over from politics into the field of industry. Democracy will not require less skill of economical leadership than one-man rules; it will require more. And this is true because its aims are broader and because it attains its aims, not by brutal coercion, but by a process which requires a finer man. The process is one of persuasion and due compromise; it requires purity of purpose. To-day business management more than ever before needs a special class of executives who shall be its tribunes with labor and its statesmen in framing labor policies.

It has already been pointed out that the United States Employment Service has undertaken to supply war plants with labor; clearly it is incumbent upon the manufacturer to make the best possible use of that supply when it has been made available for him. The employer realizes this; he sees that, if the maximum of efficiency is to be attained, the efforts of the United States Employment Service in his behalf outside the plant must be supplemented by his own within. This means the reduction of his labor turnover, which in turn will mean increased production. The question that he asks himself is "How?" Under present conditions there is but one answer—improved working conditions for his employees. He must take the best possible care of his labor if he would keep it. His production and his credit with the United States Employment Service suffer if he does not. With this problem before him, the employer turns to his employment manager, from whom he has the right to expect advice as to definite methods to be pursued and suggestions as to the specific application of well-established principles to the particular problems of his plant. And the employment manager, so approached, renders decisions often of utmost importance.

Increasing the Frontage of American Seaports

What Was Done in Foreign Ports—Mechanical Appliances for Unloading—Mistakes of Early Port Engineers

BY H. MC L. HARDING*

ALL that most ports need for the present is to discharge and load ships, barges and lighters with greater rapidity; that is, three times faster than is done at present, utilizing their, often present, extensive piers and bulkheads. This is easily, quickly and economically possible. But to do this there must be no congestion points, either on the side of the pier, on the pier, at the entrance to the pier or elsewhere.

The above is equivalent in results to increasing the present berthing frontage three times. In addition, the short holding areas must also be equivalent to three times as much in holding capacity.

This is to be taken as an average.

No one would question that, if there were three times as many piers and bulkheads as at present, many ports would have a great surplus.

Not only is this three times the increase possible with the present linear frontage and surface area, but also the American terminal engineer naturally can improve on foreign installations in adapting them to American conditions.

Many other foreign ports having similar unfavorable conditions have obtained this threefold result. These pioneers learned their lesson many years ago, being forced to it by an active mercantile marine. They have written down the exact number of tons they were transferring when their conditions were the same as at certain American ports, and what the tonnage was after improving. They employed water (hydraulic), steam (the engine), and electricity (the traveling hoist).

At first the various ports tried different methods, but finally almost all foreign ports followed practically the same terminal principles.

A barge and lighter, even where two were lying side by side and were without masts, were unloaded by their mechanical appliances, which would have been impossible with cargo masts.

A space alongside of the pier, 8 feet × 8 feet = 64 square feet, easily congested by one or two winches per hatch, was not what they used for discharging ships, but served a space 40 feet × 100 feet, or 4,000 square feet, without rehandling or moving the machine. By these machines combined with the ship's winches, six packages or drafts were going through the air at one hatch at one time instead of, as is usual at Pacific ports, one, or at the utmost, two drafts. Instead of building new piers, by an investment of one-tenth the cost of a new pier they obtained equivalent results.

These port engineers, from their experience, realized evidently that operative conditions were factors of the greatest importance, and that a one-story shed without columns, without elevators, without chutes, without other floor incumbrances, was far less easily congested than when the unavoidable elements of a two-story shed were present. They also knew that a one-story shed, 30 feet clear space beneath the trusses, had a greater holding capacity than a two-story shed 36 feet in height. In the

* Terminal Engineer, New York.

one-story shed there were no obstructions, greater speed and less cost of operation, and less initial investment. They had learned from daily operation the value of conserving floor space, utilizing unoccupied air spaces, and the necessity of coördination between railway car and vessel.

Although not in their records, such early port officials probably made trial by error, which mistakes should not to-day be repeated by those just entering into a new era of port development, due to a great merchant marine and a domestic and foreign commerce unequaled in the history of the world.

There can be no doubt also as to which will be the great port of the Pacific whose commerce will equal that of the port of New York if it will avoid the mistakes of the past and profit from the experience of others. The port to which I refer is, of course, the port of San Francisco.

Effective Arrangement of Departments in Shipyard Organization

Shipyard Divisions—Relations Between Organization Departments and Production Departments—Duties of the Chief Engineer

BY G. F. S. MANN, B. S.

THIS article is written with a view to helping the new small shipbuilding companies that have been formed within the past year, and so will no doubt seem elementary to some of the older engineers who read it. Unfortunately there is a complete lack of modern organization in many of the smaller concerns now engaged in building ships, with little knowledge also of the different departments essential to the economic production of ships, which is lamentable. For it is only by having the necessary number of departments, each responsible for its own particular kind of work, that mistakes can be avoided, and that, when a mistake does occur, the man who is responsible for it can be quickly found and the mistake remedied.

A shipyard should be divided primarily into two parts, namely, the plant organization departments and the production departments. These are again sub-divided into many branches, as will be shown later. Unless the plant organization departments keep the yard properly equipped and in proper working order it is impossible for the production departments to build ships economically, and so the plant organization departments will be dealt with first.

Division of the Organization

The plant organization is usually made up of the following branches:

1. Main office (general manager).
2. Auditor's office.
3. Cashier's and purchasing offices.
4. Plant engineer's or maintenance department.
5. Material department.
6. Miscellaneous departments.

Most of the above names are self-explanatory, but the work of some of these departments will, nevertheless, be explained.

In the auditor's office are, (a) the accounting division, (b) the ship and the plant cost division, (c) the timekeepers, and (d) the piecework counters.

The plant engineer's department is responsible for all the engineering work of equipping the yard and maintaining it in working order. The installation and maintenance of tracks and the building of shipways is the work of the civil engineer, who is one of the plant engineer's staff. The work of erecting the necessary buildings and equipping them with proper machinery to do the ship work is done by the plant engineer, who is responsible also for the air, steam, electric and water lines.

The material department usually consists of the following divisions:

(a) Material agent.
(b) Requisition division.
(c) Receiving and shipping divisions.
(d) Transportation department.
(e) Accounting department.
(f) General storekeeper.
(g) Warehouse.

Among the miscellaneous departments are listed (a) the watchmen, (b) the employment office, (c) the dispensary, etc.

Division of the Production Side

The production side of the yard should be divided first into two parts, namely, the hull department and the engine department. Each of these is again divided into two departments, the hull department consisting of the naval architect and his draftsmen, and the yard hull department, which does the actual building of the ships. Similarly, the engine or machinery department has two divisions, these being the chief engineer, with machinery draftsmen, and the yard machinery department, which makes the machinery and installs it in the ships.

The usual departments in each of the above four main divisions will be explained next in the order in which they were mentioned.

The naval architect has to make the necessary corrections in the standard plans now issued by the United States Shipbuilding Board, report any errors which he finds, and supervise the hull drafting department, which should be divided into four sections, viz., the structural drafting, ventilating system drafting, the hull piping and the hull machinery drafting.

The yard hull department builds the hulls of the ships and installs in them that machinery which is commonly called hull machinery and also the hull piping. From this it will be seen that the work of the yard hull department covers many trades. The essential sub-divisions are listed below:

(a) The hull superintendent.
(b) Lumber shed and joiner shop

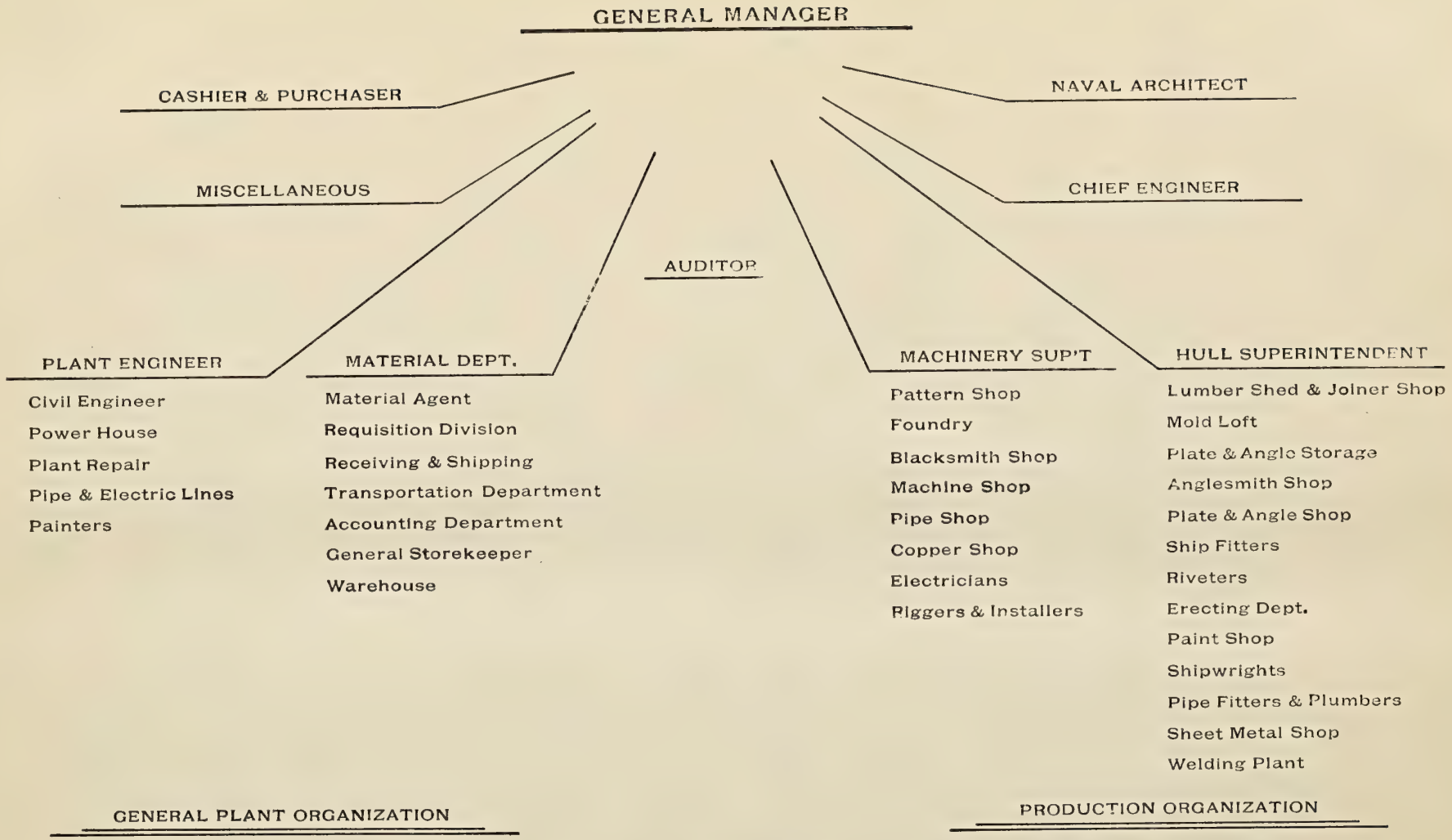

Fig. 1.—Diagram Showing Shipyard Organization Departments and Production Departments in Their Relation to the Office of the General Manager

(c) The mold loft.
(d) The plate and angle storage.
(e) The angle smith shop.
(f) The plate and angle shop (the fabricating shop).
(g) Ship fitters.
(h) The riveting department.
(i) The erecting department.
(j) The paint shop.
(k) The shipwrights.

The above are necessary for building the hull only, and the following departments are required for fitting the hull machinery and piping and rigging the ship:

(l) Pipe fitting and plumbing department.
(m) Sheet metal shop.
(n) The welding plant.
(o) The rigging loft and ship riggers.
(p) Laborers.

Division of Kinds of Drafting

The chief engineer directs the hull drafting room and may sometimes superintend the machinery installation in the ships. The engine drafting is usually divided into the following branches:

(a) Main engines and boilers.
(b) Propellers and shafting.
(c) Auxiliary machinery, such as pumps and condensers.
(d) Electrical equipment.

The yard machinery department is made up of the following branches.

(a) Pattern shop.
(b) Foundry.
(c) Blacksmith shop.
(d) Machine shop.
(e) Pipe shop.
(f) Copper shop.
(g) Electricians.
(h) Riggers and installers.

Summary and Conclusion

It is good practice to have, in addition to the above departments, one known as the superintendents' department. This will consist of the inspectors, men who follow progress, and the statistical clerks. Some of the small companies think that inspectors' and the progress department are quite unnecessary, not realizing that by efficient inspection a great deal of incorrect work which now has to be taken out of the ships and replaced could be avoided. I know of an instance of a ship having been planked for four working days without any attention being paid to the blue-print directions, with the result that four more days had to be spent in taking down this work, which was a total of eight days lost. I mention this merely to show how easily an inspector can save time and money for a company.

In conclusion, it seems to me that the simplest way to stop the wastage which still unfortunately occurs in many yards is to get the necessary departments established and then see that each of these is capable of doing its own work. If mistakes then occur it is an easy matter to fix the responsibility, after which steps may be taken to prevent a repetition of these mistakes, in so far as the human element, always an uncertain quantity, can be made to guard against them. System in an establishment will do this, however, provided the system is closely held to and taken seriously by all involved. In some shipyards to-day, system is a thing but little known.

American Shipping and Shipbuilding

THE position and prospects of United States shipping and shipbuilding are provoking considerable speculation just now, says *Engineering* of London, and a few facts and circumstances relating to American conditions may usefully be set out. In view of her resources up to a few months ago and her available volume of skilled labor, America is now doing wonderfully well. Thus she is playing, and will play, a highly welcome part in helping to solve the shipping problem, and it is not unlikely that after the war that country will be our chief rival on the ocean carrying trade as she was in the first half of the nineteenth century.

In the middle of the last century the Americans came near to beating us in ocean shipping; and history may possibly repeat itself. Ambitious plans are being made for a permanent revival of the United States merchant marine. But we may rest assured that we shall not experience from America that kind of State-subsidized and bounty-fed undercutting of freights and passenger rates that characterized German competition before the war, and will govern it again if we take no measures to check it. American competition will be fair and above board, If, as is probable, American shipping is subsidized, it will only be to an extent sufficient to balance the difference between costs at home and abroad, in strict accordance with the protective principle of United States law.

Appointment of Shipping Board

Since the war started more than $250,000,000 (£52,631,790) of new private capital has been invested in American shipping enterprises, and perhaps an equal amount in shipbuilding. A Federal Shipping Board has been appointed with power to raise almost unlimited sums of money from the building, purchase and hire of vessels; and large amounts have been spent on extensions and improvements of the naval yards. When war broke out the tonnage of United States shipping engaged in foreign trade was only, in round figures, 1,000,000 tons, though the country possessed about six times that tonnage employed in the lake, river and coastal trades. Britain had 18,000,000 tons of ocean shipping, and Germany 5,500,000 tons. Only about 8 percent of America's oversea commerce was carried in American vessels.

The great boom in American shipbuilding and its twin trade shipping is not, however, a creation of the war, though it has been accelerated by war. It is part of a national movement for more ships, inaugurated before and apart from the war. More than twenty years ago a Merchant Marine League was formed in the United States to advocate the restoration of shipping. When it was found that the Panama Canal was at last likely to be opened to traffic the "more ships" question became one of practical politics. How far the current revival will be carried—how far American shipping will rise in the international scale—whether we shall be closely run or beaten by the Americans—will depend partly upon the measures that are taken to foster United States shipping, and partly upon our own efforts to maintain our supremacy. If our workmen and their unions are unreasonable, if our engineers will not adopt standardization and other economical methods, if our builders will not cooperate and combine, and if our statesmen will not recognize the rights of enterprise and stop unfair foreign competition, then nothing can prevent such a growth of American and German shipping and such a decline of our own as will spell the downfall of the British Empire. The subject is certainly worthy of considerable thought and speculation.

Fig. 1.—Boiler Being Placed Aboard Ship

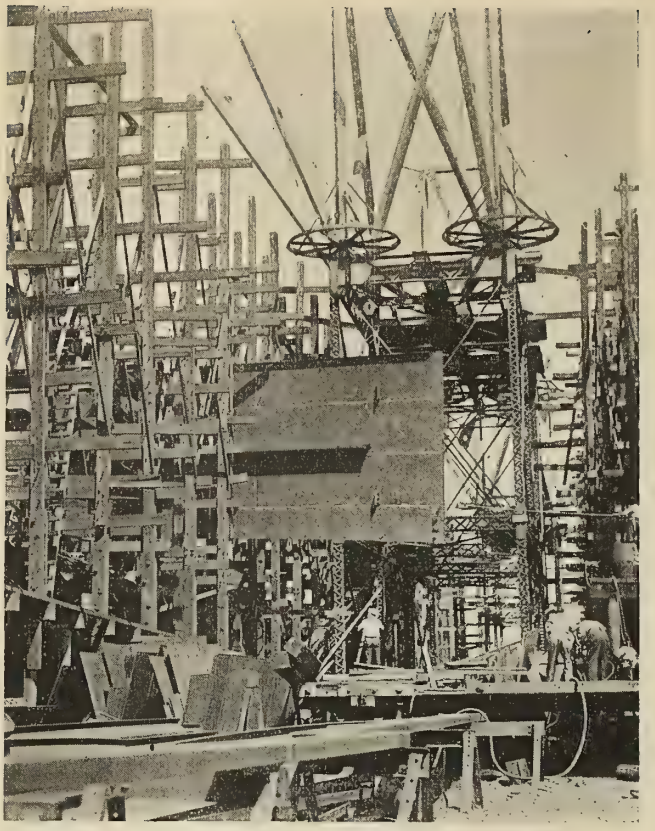

Fig. 2.—View of Ways Showing Plate in Suspension

Methods Used at Shooter's Island for Constructing Standard Ships

Serving Individual Ways—Method for Increasing Output—A Well-Lighted Boiler Shop—Handy Plate Lifting Clamp

BY CHARLES M. HORTON

WITH a record of 135 tons of fabricated steel a day—as against 65 tons a day a year ago—the Standard Shipbuilding Corporation, Shooter's Island, New York, is rapidly coming into the forefront as a producer among the Eastern group of yards. Ten standard type hulls already have been launched, with two additional United States mine sweepers, and six more ships are on the ways in various stages toward completion; all of which proves that the employees of the Standard Shipbuilding Corporation—there are seven thousand active workers on the payroll—are grimly driving rivets and punching steel.

The yard at present has six ways, with two more being constructed. Each is served by four towers and eight derricks. Notices posted prominently keep the workmen informed as to the date upon which the keel of each ship was laid and the scheduled time for launching. This acts as a spur to increased endeavor on the part of the men, and also engenders no little rivalry among the different groups at work upon their individual ships, since these daily bulletins conspicuously posted reveal the progress being made. "We're falling behind!" and "We're doing better, boys!" are two that struck the writer recently. These, painted in letters a foot high, so that he who runs with a bucket of oil may read, cannot but act as a strong incentive to extra exertion, especially when, as was the case for a time, bonuses are offered for records made in cutting down the time, over the scheduled date for launching, at which the ship is actually ready for the water.

Such measures for increasing the output are effective. That they bring other and larger rewards is betokened by the fact that recently the Emergency Fleet Corporation granted Shooter's Island the necessary money to increase the capacity of the yard by two additional ways, work upon which is already in progress. Instead of six, therefore, Shooter's Island will have eight ways before the end of the year.

The fabrication shop consists of five bays, two for boilers and three for plate. All material entering into the construction of a ship is unloaded from lighters directly into the storage yard, where it is handled by locomotive cranes and consigned to its proper place among its kind. Here each piece is carefully numbered and stamped for quick selection later. When it is required it is again picked up by the locomotive cranes and conveyed to a point just inside the particular bay where it is to be fabricated, and directly under the shop elecetric cranes. Then the electric cranes take it to workmen engaged in laying out and marking off. Each employee follows a certain fixed task, and with the plate in readiness for the shears or the punches, or the machines for planing, the overhead cranes are again brought forward and quickly convey the plate to the machines.

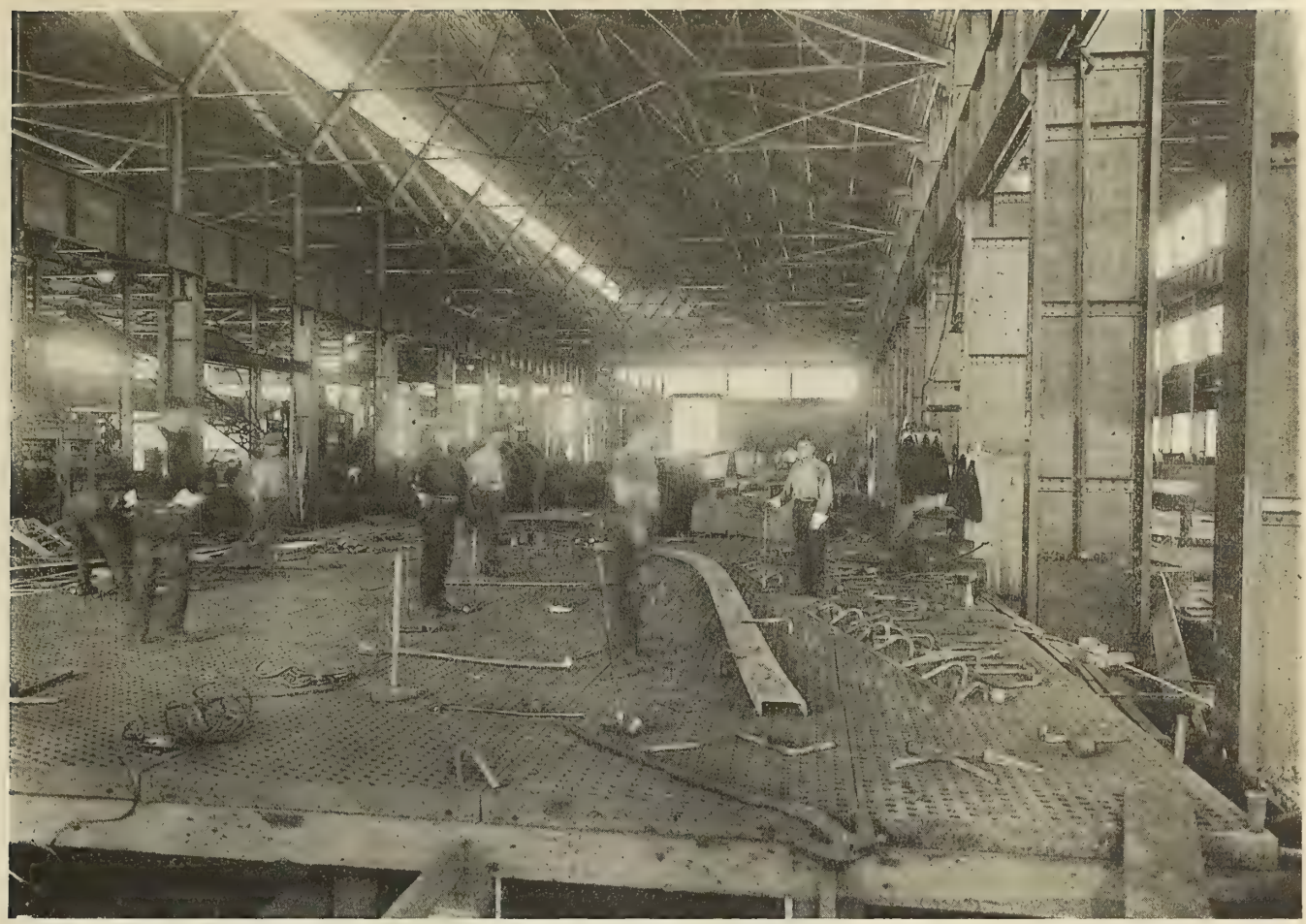

Fig. 3.—Interior of Angle Shop Showing Channel in Process of Bending

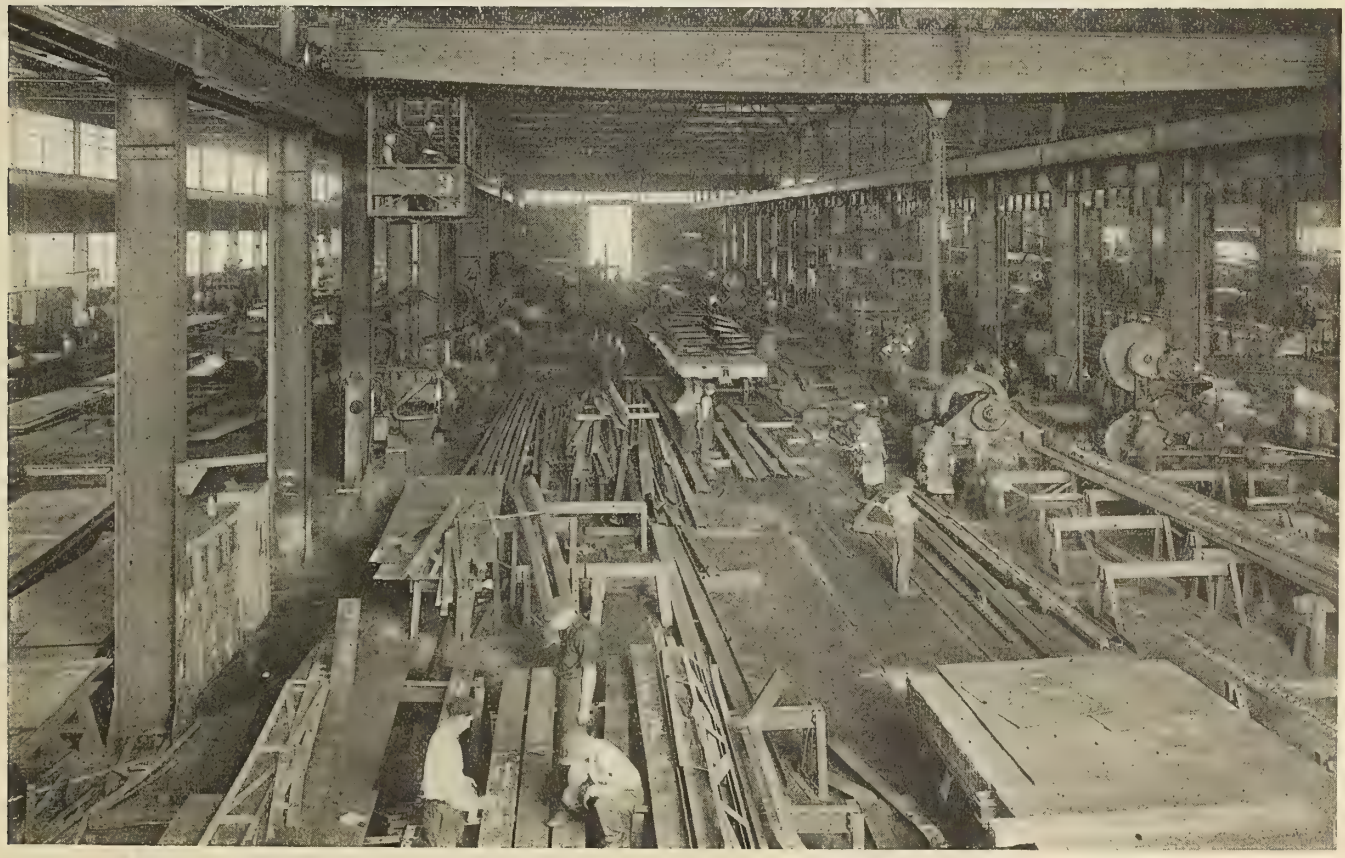

Fig. 4.—Bay Where Angles and Channels Are Laid Off and Machined

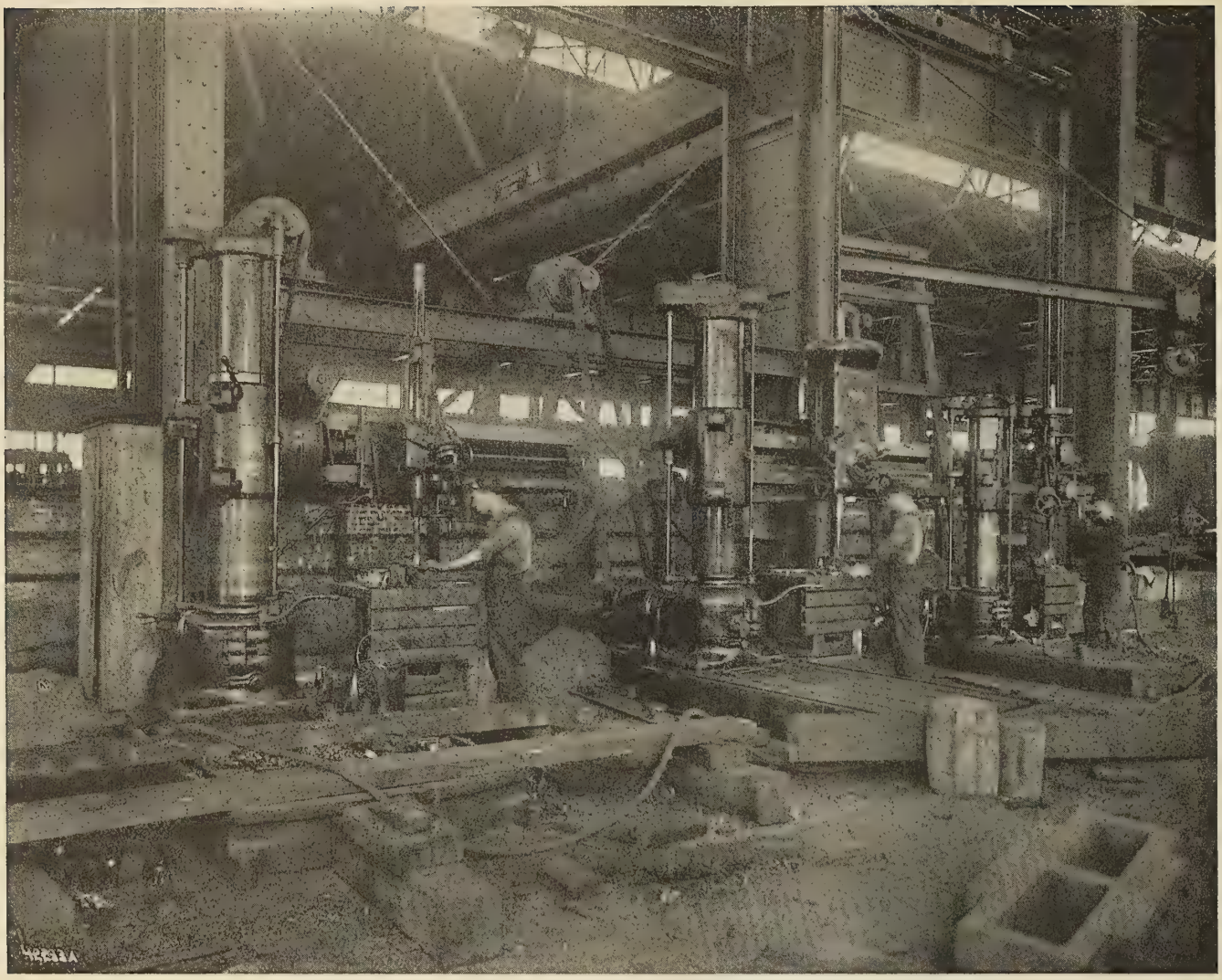

Fig. 5.—View Showing Gang of Drill Presses in Operation

There is in use in the yard a clamp that was patented by one of the foremen for the work of lifting plates. It consists of a lever bolted into a clamp in such a manner as to grip the plate through friction the moment pull is exerted upon the clamp by the overhead crane. As a device offering quick attachment and detachment, with a maximum of safety, it is beyond anything the writer has yet seen in use for this purpose, and unquestionably admits of increased efficiency in the work of handling plate material in the storage yards. It is capable of lifting two, and even three, plates at one time, and does this through no other holding device than the one exerted through plain friction. It would probably be well for the other yards in the Emergency Fleet Corporation to adopt this clamp, since its value has been well established in the yards at Shooter's Island.

The boiler shop, which is 400 feet long and 60 feet wide, is turning out boilers at the rate of one every six and a half days. The boilers are of the Scotch type, 14 feet 6 inches diameter and 12 feet long, with an indicated horsepower of 850. The shop just now is undergoing expansion, practically doubling its capacity, and with the extensions completed and the necessary new equipment installed, the output is expected to be doubled also.

The boilers, when in readiness to be transferred to the vessel, are hoisted by means of overhead cranes to flat cars, which convey them to the yard frontage where they are set aboard the ships as soon as these are launched. Very little delay occurs in lifting the machinery into place, once the vessel is afloat. This includes boilers as well as engines, auxiliary parts of engine room equipment and all the appurtenances.

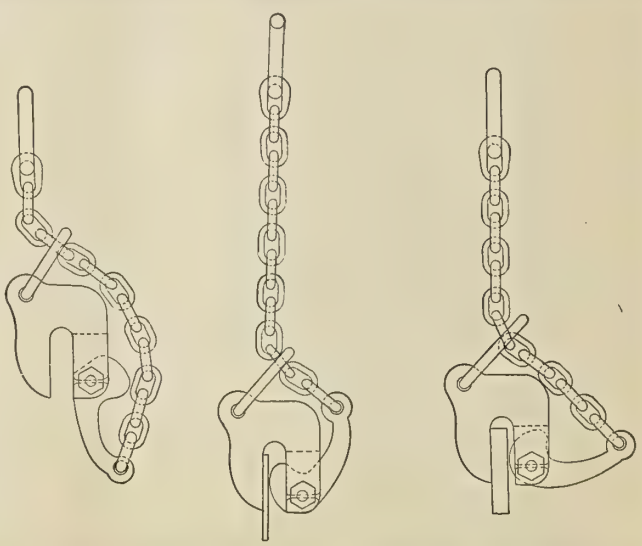

Fig. 6.—Sketch Showing the Various Positions the Clamp May Take When Lifting Plates

To one looking down one of the bays of the boiler shop

where boiler heads are in process of shaping, it will be seen that there is plenty of light on the work, somewhat more than in many boiler shops, and in this light the work of shaping the heads proceeds in a systematic manner. The shop is roomy, as well as well lighted; and though there is much work going through all the time, but little sign of the usual boiler-shop congestion is in evidence in this bay. As a matter of fact, there is very great freedom of movement in evidence everywhere in the plant, considering its size.

Compressed air is the life of a shipyard, just as air at atmospheric pressure means continued existence to all animal and vegetable families. That H. Norman Scott, chief engineer, may know at any time the precise pressure under which the air guns are being worked, he has had installed in his office, immediately under his eye, a pressure gage connected directly with the yard piping. In this way, whenever the pressure falls off, he is informed of the fact, and quickly telephones the operating engineer in the compressor house, who promptly looks to his own gages, and rectifies the evil.

That is but one of a number of methods through which production is kept up to highest pitch. Another is the facility with which workmen coming into the yard resume

Fig. 7.—Patented Plate-Lifting Clamp

Fig. 8.—View Showing Boiler Shop Bay Where Heads Are Heated and Shaped

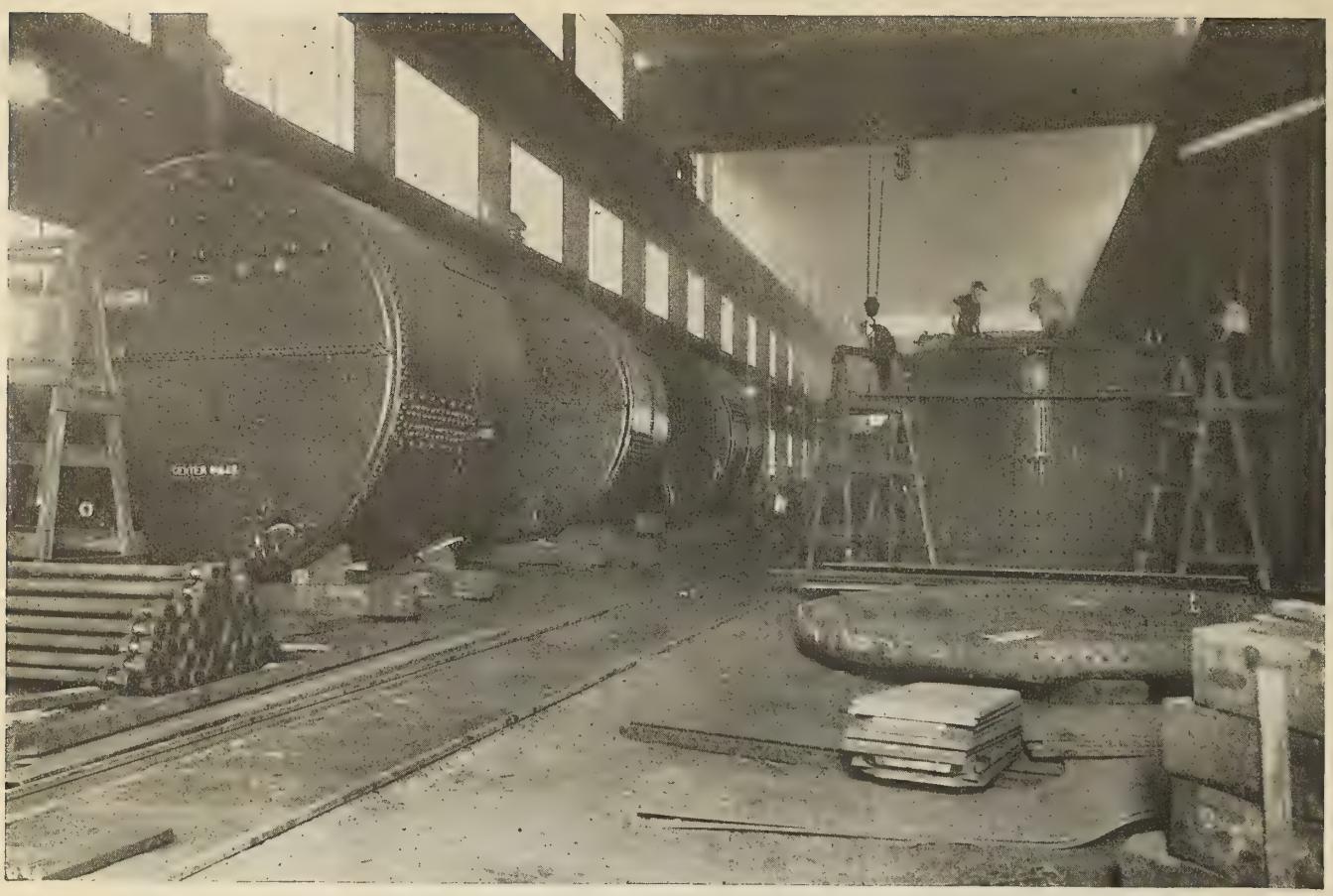

Fig. 9.—Section of Boiler Shop Showing Three Completed Scotch Boilers

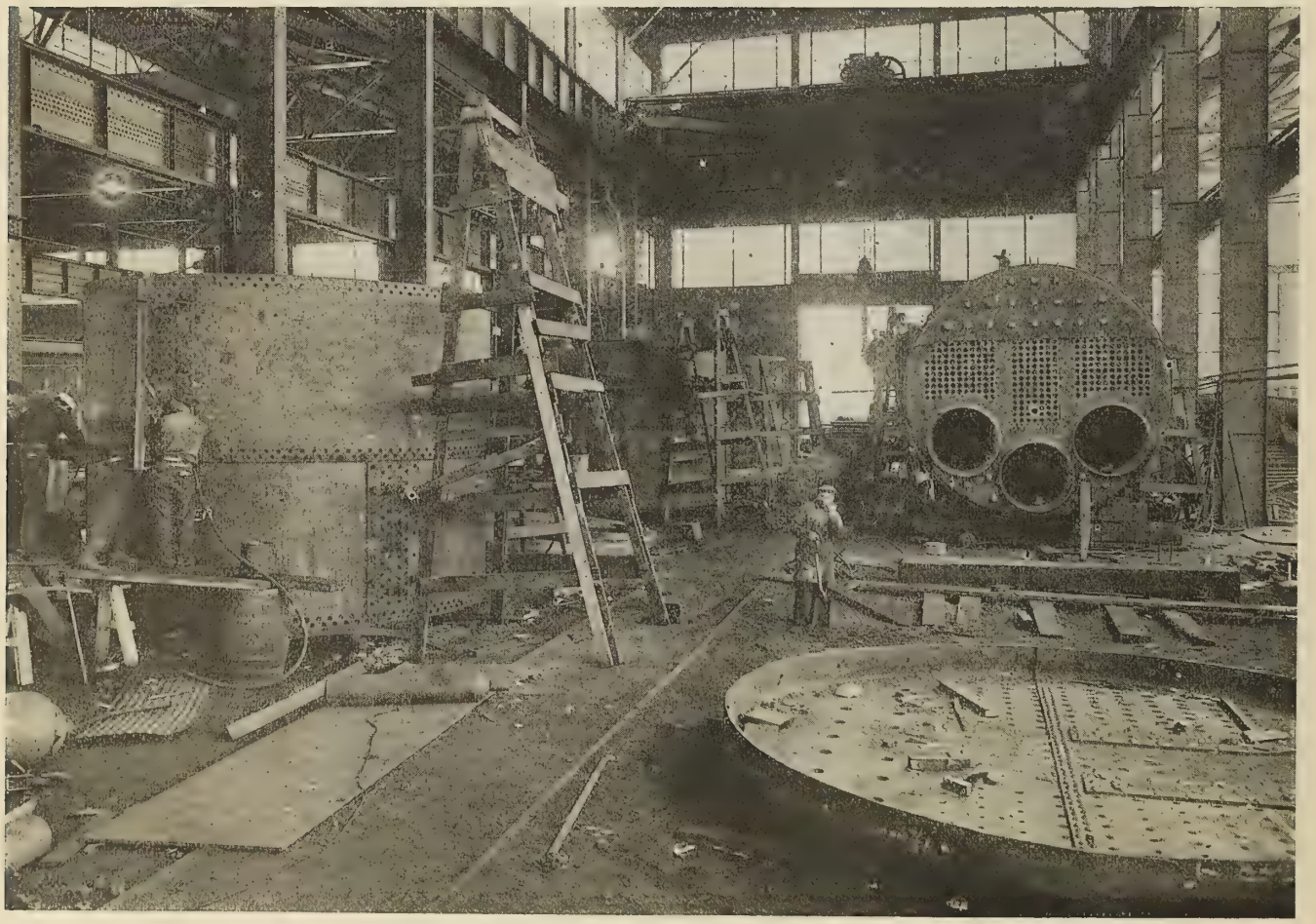

Fig. 10.—Another View of the Boiler Shop Showing Boiler in Course of Assembling

Fig. 11.—Angle Cutting Saw with Water Cooling Device in Operation

Fig. 12.—View of Interior of Ship's Hull with Frames Being Riveted

Fig. 13.—Exterior of Section of Standard Shipbuilding Corporation's Yard

their allotted tasks without loss of time, in that all working tools are kept in a shed immediately underneath the ways supporting the hull upon which the tools and the different gangs are engaged. Still a third is a sort of diagram, a blueprint, known as a "thermometer chart," copies of which are posted freely about the job and in the lofts and the shops to keep the men informed of the progress being made on each ship. Altogether, considerable detailed thought has evidently been expended generally toward holding production to maximum.

Where the Kaiser's "Meteor" Was Built

In a measure, Shooter's Island is famed as the yard where, some eighteen years ago, the keel was laid for the *Meteor,* a yacht built for the Kaiser. The spot is still there, of course; only now it is filled in in such a way that no ship will ever again be built on this unhallowed ground. To make this doubly certain, the ground is piled high with several thousand tons of plate, which effectively closes—or ought to close—Germanic performance in this country for all time.

The growth of the yard has been epochal. This is revealed in several ways. One is that on the first of the present year the number of workmen, both yard and office, lay in the neighborhood of three thousand, whereas to-day there are over forty-five hundred names on the books. Another is the sudden increased acreage. Fills have been made steadily from the beginning of the year, with the result that to-day a number of acres have been added to the available working space. One thing more. There are two ferryboats plying between the mainland and the yard to-day where before the present activity began there was only one ferryboat connecting the two points. And all this increased activity within a short twelve months!

There are no cross tracks on the island. All tracks lead radially from the shops to the ways or the water front. And that has its value. There is no stoppage confronting the locomotive cranes in their work, due to a blocked crossing, nor is there waiting one upon another of the locomotive cranes due to defective turn-tables or the laborious operation of these. Another thing, the yards throughout are served with electric trucks, rubber-tired, a number of which are fitted with cranes of particularly large capacity. Formerly, before the introduction of these, considerable material was transported about on flat trucks on rails, with laborers shoving the material along. This now, however, is completely done away with. The material is moved about with surprising speed, which is another important factor in holding the yard up to maximum output.

Size of Standard Ship

The Standard Shipbuilding Corporation, for a yard hurriedly whipped into shape for work of this capacity, presents an apparent efficiency that might be well worth taking pattern after on the part of other yards in the control of the Emergency Fleet Corporation. I say this with some reservation. One can't always tell, you know. Nevertheless, the standard ship itself, with a length of 392 feet 6 inches, a beam of 52 feet, with 7,500 deadweight tonnage, and making on an average of 10½ knots under a single triple-expansion engine operating with three boilers, each having three furnaces, is a unit of no mean proportion with which to grapple successfully in quantities. They are doing it here, however, and doing it to the satisfaction of the head of the Fleet Corporation, Charles M. Schwab.

The Heavy Oil Engine*—II

Relative Values of Oil—The Spray Diesel Valve—Ignition Conditions—Discussion of Structural Elements

BY CHARLES E. LUCKE†

THE heavier the oil the lower its vapor pressure or that of its heaviest constituent, then the hotter that mixture must be to be a gaseous mixture; and the hotter it is, according to this table, the lower the compression it can stand without self-igniting. Therefore, only those fuels that have high vapor pressures or that can make cold gaseous mixtures can be treated with the whole mass under compression. Those oils which are within the heavy class of oils, and have so low a vapor pressure as to require 300 degrees or 400 degrees initial temperature outside the engine plus a couple of hundred degrees rise in temperature coming into the cylinder, can be compressed hardly at all. Therefore, such heavy oil engines cannot by any possible conformity with Nature's laws be efficient. It is fundamentally sound that all those schemes for heavy oil engines that involve vaporizers are utterly incapable of producing an efficient engine.

For some reason or other everybody playing with this class of machine in the early days seems to have been absorbed with the idea of cooking the oil; they seemed to feel that it had to be roasted to death, and then wondered why they could not carry any compression, and why the efficiency was so low and the fuel consumption so high. This fundamental impossibility, against which mechanical ingenuity is absolutely helpless, never hit them at all; and that situation has lasted from the early seventies up till to-day, and people are still inventing schemes of this kind.

How to Get High Efficiency

It is perfectly clear that to produce a high efficiency, and at the same time a fairly high mean effective pressure in the interest of high power, the first and fundamental requirement is not only high compression, but to keep the oil away from the air until the time comes to burn it. By keeping the oil away from the air during compression, any compression you please is yours for the asking. It is purely a matter of mechanical clearance between the piston and cylinder head. Therefore, it would seem possible to secure almost any efficiency in such an engine with the delayed introduction of oil under the system which has received the name of late injections engines. Late injection is fundamental to efficiency.

Now the late injection principle of working is highly developed mechanically only in Diesel engines, and therein you see there is a little scientific engineering anomaly. The desired and necessary principle of high compression with delayed injection has been developed in its application to the less promising type of cycle—the Diesel; and the more promising type of cycle, the Otto—that which promises a given fuel consumption with half the compression of the Diesel—has been delayed, so that our engines have been highly developed along the less promising line without scarcely any development at all along the more promising line. Do you wonder, then, that with the success we have had with the less promising we may expect and look forward to much greater success with the more promising field when it is vigorously followed up?

We have come now to this point: That after compression we are to introduce the oil, and the oil may be introduced in such a way as to produce an explosion or to burn at substantially constant pressure without explosion. I want to point out to you next the controlling means in use for doing either one of those things or both of them.

The Diesel Engine

First, as to the Diesel. At the time the oil is introduced the temperature of the air is something higher than the ignition temperature—200 degrees, 300 degrees, 400 degrees or 500 degrees higher than ignition temperature—and so far in all these engines the oil has been introduced and sprayed by the aid of compressed air. How is the feed of oil controlled so that the rate of combustion shall be just enough to prevent the pressure falling along the re-expansion line, but kept substantially constant? That is entirely a matter of spray valve design. If you set yourself the problem, especially those of you who have not worked on this problem, of designing a scheme to squirt oil into a cylinder against 400 pounds or 500 pounds compression pressure at a graduated rate for 10 percent to 15 percent of the stroke, so as to hold the pressure constant, the oil burning as fast as it enters, you will find some little problem on your hands, and I venture to say that eight out of ten men will start with some kind of cam-driven pump. Now, that will not work at all. The thing that is relied upon is the tendency of the oil to stick to a metal plate. To make that clear, consider the ordinary spray Diesel valve with a fairly heavy stem in a casing. Beyond it there is a graduated orifice outlet, which is the spray orifice and is changeable in size to suit the viscosity of the oil. The oil is pumped into the chamber or space between the casing and the valve stem by a pump which has only one duty to perform, and that is, measure the amount, not time or graduate of the injection. That cannot be done, or it never has been done. I do not think it can be done. The oil, in the ordinary course of events, is put into the spray valve chamber before the injection is wanted, and it will run down to the bottom more or less fast. If the valve be lifted and the oil itself has reached the bottom or valve seat, the first thing to happen after the opening of the valve is a squirt of solid oil with no spraying whatever. In an instant the oil is all out, and, instead of maintaining a graduated combustion for 15 percent of the stroke, we have a lump of oil squirted in without spraying or graduation. There will be a certain amount of combustion, but only part will burn; the rest makes a little lump of carbon.

Action of Oil in Chamber

Now, to secure graduation of oil feed, all that has been done is to stick a lot of plates with holes in them in the space between valve stem and casing. These plates have definite thickness spacing and drilling; sometimes they are given special forms and surface finish, each designer adopting an air of great mystery about his arrangement and claiming absurd superiority over his rivals.

All that these things do in the oil chamber is to provide an extended surface to which the oil naturally tends

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* Paper read before the Engineers' Club of Philadelphia, January 29, 1918.

† Professor of Mechanical Engineering, Columbia University, New York.

to stick. It might be filled with shot and it would no doubt work just the same. The oil is pumped into this chamber, and when the valve is pulled open the oil tends to travel down, partly by gravity and partly by the surface frictional influence of the air on the oil. The oil, however, is sticking to that labyrinth surface. The oil chamber is nothing but a mechanical labyrinth. That is what it is called for want of a better name. And that is the only means that works as a graduator of oil feed, except one. The other one surrounds the valve stem by a sort of Venturi tube casing, between which and the valve body is found the oil receiving chamber. There are two holes in the Venturi partition between the oil chamber and stem chamber—one from the Venturi throat to the bottom of the oil, the other imposing the total air pressure on the oil surface. When the valve is open the compressed air flowing through impinges on that hole to the surface of the oil and builds up its total pressure, while at the same time the other hole, being at the throat of the Venturi, is subjected to a lesser pressure by the air velocity head, thus developing lifting tendency on the oil, and we have a regular vacuum flow injector. This action of the former one of the labyrinth forms the basis of all the schemes for graduations of feed of oil from the spray valve body to the spray valve nozzle, so that the oil feeds during the required period of time at a more or less steady rate to this nozzle, and it is torn to pieces or sprayed by the velocity of the air issuing from it. It is clear that with this arrangement the rate of oil flow, the time of oil feed, and the rate of combustion will vary with the viscosity of the oil.

Discussion of Explosive Mixture

Should such a valve be adjusted by the spaces and orifice size to give the required feed for a given oil, and then supply an oil of lesser viscosity, or maybe the same oil supplied hotter, or really a less viscous oil, then it will discharge much more rapidly, and instead of a horizontal combustion line there will be a rapid rise of pressure somewhat like a slow explosion. This indicates what is necessary if we desire to make a spray nozzle suitable for producing an explosion. To produce the explosive mixture and secure explosive combustion of oil with the spray nozzle, the first step necessary is to reduce the flow resistance in the body of the nozzle by removing a considerable amount of the labyrinth surfaces or by reducing the viscosity of the oil by heating it. As a result the oil will be discharged much more rapidly, and if enough resistance be removed from such a spray nozzle it would give a substantially instantaneous injection of oil as a liquid spray. If that occurred we would have a more or less finely divided spray scattered through the mass of compressed air, and if the air is not up to ignition temperature then we would have produced what might be called a liquid explosive mixture, ready for any kind of ignition that is handy. It is a liquid explosive mixture because no attempt has been made to vaporize the oil. All that has been done is to make really fine fog of liquid drops suspended in the air, scattered through the combustion chamber. To get such an explosive mixture or charge ready for ignition it is necessary that no part of the interior walls or the air itself touched by the oil be up to ignition temperature, because if the air should be up to ignition temperature, as would be the case with the Diesel, then the oil would ignite as it came in, before the oil spray charge was scattered through the air. To obtain the explosion it is necessary to get all the fuel into the cylinder and scattered through the air before it is ignited, just as with delayed electric ignition. On the more desirable Otto cycle with its explosion it is necessary to prevent the air reaching ignition temperature during compression; it must be capable of igniting the oil, and the ignition, by whatever means is relied upon, must itself be delayed long enough to let the whole charge of oil get in the cylinder, because unless it is in there is nothing that can explode.

Now as to igniters. The common thing has been a hot plate; sometimes a bulb of spherical form with a neck; sometimes a hemispherical bulb without any neck, just forming a cylinder head, and sometimes all sorts of weird curves and twists and shapes—every one of them the subject of a patent. Now, of that collection, what is good and what is bad? There is a simple way of sizing it up. The hot metal—that is, the igniter—must be so related in position to the injection point that no part of the oil reaches the hot plate before all of it is in the cylinder, and the shape such that no part of the oil reaches the hot plate before any other part.

What Happens in Combustion Chamber

Let me illustrate and you will see the force of this principle. Consider a cylinder with a spray valve at one edge of a nice hemispherical plate, red hot, the oil being sprayed at an angle toward the plate. There have been many made like that. The hot plate comes up quite close to the injector, which discharges a more or less conical spray. Some of the oil will strike the hot plate before the oil is all in the cylinder, and considerable of the air. The first oil that hits that plate is going to fire the charge, or so much as has entered, and much of the air is utterly inactive and cannot do anything, as it has received no oil. At the same time, an explosion of part of the charge has taken place and the rest is still coming in. What does it meet on the way in? A red hot—yes, a white hot—mass of inert gas. What will happen? Nothing but crack, liberating free carbon and carbon monoxide. The unused and unmixed air leaves free oxygen in the exhaust, and with it the unburned fuel appears as carbon monoxide and much free carbon with plenty of solid carbon cake inside. A very low mean effective pressure and low efficiency will result, and the engine will be very dirty.

Attainment of Ideal Conditions

The ideal condition is that in which no part of the oil strikes the igniter sooner than any other part, and none of the oil strikes the hot plate until all the oil is in. Now, what kind of arrangement would give that? Suppose we had a spray valve making a cone-like spray discharging axially in a hemispherical head, the center of which is the spray orifice. Then at the time the oil at full load had reached this hot ignition plate the last oil would have come in if the dimensions were right. That would be in conformity with the principle laid down. That arrangement will give anywhere from 50 percent to 100 percent more mean effective pressure than the non-symmetrical arrangement previously described, and with it any compression you please may be carried. It does not matter how hot that latter plates gets, whereas the former has to be run cool on the side where the oil first strikes, and yet hot enough elsewhere not to miss fire. At full load it tends to get too hot and pre-ignite and knock its head off; with a light load it fails to get hot and fails to fire at all. And so the engines in that class are always provided with some kind of scheme to prevent their getting too hot at heavy load and too cold at low load. The popular water injection scheme usually does nothing but wash the lubricating oil off the cylinder wall.

For a long time, practically throughout the whole history of this art, this condition of necessary relation be-

tween the spray valve and the hot plate igniter has not been realized, and yet hot plate igniters have been in almost universal use. Now, hot plate igniters themselves are a bar to progress, because if we use a hot plate igniter it has to be an outer wall. It has to be an outer wall so that you can start it with a torch and still not burn up. An inner wall cannot be started. A hot plate submerged in a cylinder cannot be started, because you cannot get a torch at it from the outside. If a hot tube igniter be provided for starting and an internal plate relied upon for running, as is sometimes done, then you have no control over that hot plate at all and it will burn out. So a hot plate igniter has to be an outer wall to be practical, and when you have made it an outer wall to be practical, then it is not really practical, because it limits the size. That red hot plate lacks tensile strength.

Structural Debarment to Ignition

A cast iron can be found that will not lose too much tensile strength, but, nevertheless, it is very weak in proportion to what it might be. As cylinder sizes go up—and I have already indicated that one of the great fields of need for the heavy oil engine is ship work, which calls for cylinders to go up just as high as we can make then go—then the external hot plate is barred. It is not good because it is too weak structurally. Here is the place then where the functional problem leads to a structural debarment and where progress into the larger sizes requires an abandonment of the red hot plate as an igniter. Men have tried various other schemes, and there is now being attained some success with electric igniters and with moderately warmed internal hot plates, which are more properly called "warm" plates. Suppose, with reference to the latter, that we have a 300-degree internal temperature and one that would stop just short of ignition. Suppose we had a 300-degree initial temperature. Then for practical reasons about 279 pounds compression would carry the entire air above ignition temperature approximately 200 degrees, and that would not be practical with late injection. If, however, the initial temperature of the air were lower, or a sufficiently lower compression were selected, we could come within 100 degrees or 200 degrees of ignition temperature and still have a very substantial compression. As a matter of fact, it is perfectly feasible to use compression up to 175 pounds, approaching 200 pounds—possibly more—without reaching ignition temperature, provided the initial air is not too warm. Suppose we were injecting straight toward the piston and we had a spot of metal on there that did not get red hot, but raised the temperature of the air right next to it 200 degrees or 300 degrees higher than elsewhere. That is all that is necessary for ignition, and that is one way the thing might be done—a cold external wall for strength, a warm internal spot at the maximum distance from the igniter, not red hot but sufficiently warm to supply a couple of hundred degrees difference between the temperature attained by compression (which is not high enough to produce ignition) and the amount necessary to actually produce ignition at that one spot alone.

We do not know much as yet about that scheme, except that it is possible to run that way. Whether it can be developed into a practical controllable thing remains to be seen. I am inclined to think it can. If it can, then one serious bar to the increase in size and more extended use of the Otto cycle engine has been removed and a new field of most interesting and valuable possibilities opened up.

Without that, however, there is still another way of proceeding that is receiving some attention. For a long time back is has been known that with a sufficiently fine and proper kind of spray of oil into air an ordinary spark plug would serve as an igniter. With the wrong kind of spray and plug the oil would collect at the spark plug and short circuit it, but a spark plug can be made to ignite the right kind of spray just as positively as it ignites a gaseous mixture. An apparatus involving the lighting of sprays by spark plugs is going to receive considerable impetus in the near future.

A Suppositious Case and the Diesel

As to engine schemes, suppose we had a thoroughly cold interior engine—an engine the walls of which were all cold, just as cold as we can get them, and to my mind you cannot get them cold enough for a good practical oil engine—the colder the better. Into that cold cylinder we admit a charge of air and compress it, but not sufficiently to produce ignition, and when we get a sufficient compression to produce a highly economical engine as to oil and sufficient to produce a mean effective pressure approaching 100 pounds per square inch, then ignite with this spark plug. That can be done, and it is a most interesting possibility. It is particularly interesting because in conjunction with it, it is possible to use a modified oil spray.

With the standard Diesel engine the oil spray valves is supplied with compressed air under 1,000 pounds and more. Now, in the actual running of these engines the air compressor to supply that air and the air storage are just about as big a nuisance as the engine—sometimes, and often, in fact, more. If we could get rid of that it would be a splendid thing to do. A "solid" spray is therefore a highly desirable thing.

The Navy Fuel Oil Burning Spray

So far we have succeeded in making a number of engine solid spray valves that work quite well, and they work so well that I feel confident that the end of the compressed air spray is drawing near, and that thereby we are going to eliminate another big source of trouble. I am not sure that the solid injection spray I have in mind will work on the Diesel engine, because the Diesel engine requires a graduated feed, and I am not at all sure that the principle of action of the solid spray can be adapted to the graduated feed. It works splendidly with the instantaneous feed for the Otto cycle or explosion engine. There is only one principle that need be kept in mind to explain the many ways of working out the solid spray, and that principle is pretty old. It is the principle of the navy fuel oil-burning spray for boilers. The navy and other ships cannot afford to use compressed air or steam for spraying oil, as is so common on land, because they have not the fresh water with which to produce this steam. They are, therefore, compelled to use a mechanical spray, and this type of spray has been very highly developed. It involves nothing more than a minute orifice from which the oil is discharged with a combined motion axially through the hole and rotary as it comes out, the rotary motion being developed before the oil reaches the hole in a rifling tube or tangential feed passage to a little whirl chamber just back of the spray orifice. By giving the oil a whirl behind the spray orifice with a proper exit from the orifice it issues with a motion in two directions—axial and rotary—producing a sort of solid conical spray that is fine and works well in an engine. By making the passages small enough in such a spray valve so that they are practically capillary, then a direct-acting pump plunger slamming against the solid column of oil will make such a spray without any dribble at the ends of the spray period. Re-

member that no dribble at the end or beginning of a spray is permissible, because every drop that dribbles carbonizes. To avoid the dribble the only thing necessary is to get the passages substantially capillary in size, and that is not difficult. At first glance it would seem as if that boiler spray valve could not be made to work with rapid intermittence; but it can, and is so working to-day.

Matters Concerning the Structural Elements

Now a word or two on the structural side. We may assume that this functional question has in it considerable undeveloped possibilities, and that these are not mysteries, but are lines of purely rational progress, the key to which we have in every instance, and nothing is unknown except how far you can go. We know the route every time; but we do not know how far we can go. Assuming that you can see with me in your mind's eye non-Diesel, late injection, high efficiency oil engines working as well as the Diesel, or better, then arises the question: How should the structure be built? Are there any lines of standardization that can be well and properly applied there? Or is every designer to regard himself as the one selected by the Almighty to produce something that no one else ever made? For some strange reason, that seems to be in the minds of almost all oil engine designers. While for years we have been building shafts, frames and engine structures for steam engines and similar structures for pumps and compressors, just as soon as an oil engine designer gets his hand over a drawing board he wants to throw all that experience away and get up some other thing and make more trouble than do the parts that are peculiar to the oil engine.

The point of view to take with regard to this structure is this: There is no essential difference in kind, except the cooling problem, between an oil engine cylinder and a steam engine cylinder. The difference is one of degree in the structural problem. There is no essential difference —certainly none in kind—between the problem of the frame and the bedplate and the rest of the running gear of the oil as compared with the steam engine. That being the case, these queer arrangements that have crept into the oil engine field and that have become more or less standard there, quite contradicting all previous experience and established custom with the more firmly established steam engine, cannot be accepted. There is no difference whatever in the design of a column to support a bridge, a pier, or a building, or to support a statue; all that counts is the load to be placed on it. And yet the oil man has persisted in carrying out his structure from cylinder down to bedplate on radically different lines than have long been standard with steam. The result is hopelessly bad. Let us bring out some of our good old designers who understand the designing and building of structures to carry loads, and I would not tell them anything about the oil engine peculiarities at all. Some other man is taking care of that. Then we will get somewhere.

Stresses in the Cylinder Castings

Just to point out one or two things to illustrate what I have in mind, consider the most widely used Diesel cast frame structure extending from bedplate to cylinder head, and being an axially expanding cylinder line. This cylinder line is a stressed member, the stress being bursting stress, with 400 pounds or 500 pounds per square inch normal pressure at the top, and possibly an accidental maximum pressure with a pre-ignition pressure of twice that amount—1,000 pounds or 1,200 pounds per square inch. Now we certainly know how to build cylinders to withstand bursting, so this is not peculiarly an oil engine problem, except that its expansion must not be restrained. That cylinder structure is inside of a heavy casting and held at the top. This casting is practically an "A" frame with a cylindrical extension at the top; the cylindrical extension forms the water jacket and is faced at the top, on which the cylinder line flange rests. There is a slip joint at the other end of the line to allow of longitudinal expansion of the cylinder line barrel with reference to the jacketed frame. An engine built along such lines as that is fundamentally wrong, because the jacket is at the same time a frame. What is its principal duty? Its principal duty is to hold water—and anything that will hold water will do just as well—and yet you will find big engines with jacket walls of 1¼-inch cast iron for many feet in diameter. Think of all the weight that goes with that, and for what? To hold water and transmit an upward tension load from the cylinder head down to the main bearing. Nothing could be more fundamentally wrong. In the first place, as to the material, it is all cast iron and is always in tension if it is loaded at all. If it were a steam engine there would be an alternate compression and tension; but here it is tension-loaded, and if there is any worse material than cast iron for carrying a tension load, it is probably cast aluminum. Furthermore, if such a cylinder line barrel is strong enough to resist bursting, it has just twice the factor of safety for the longitudinal tension stress, which means that the double metal of line and jacket is entirely unjustified. The cylinder should be held to the frame at its crank end and the jacket eliminated as a stressed member. There is no reason for carrying a heavy cast iron wall for a jacket, when ordinary tank steel will do the job just as well and a little bit better. We have oxygen welding apparatus that will enable us to weld the edges of a thin sheet to cast iron with perfect success and with not much expense.

Paralleling with Standard Steam Practice

There is then a necessity for changing the cylinder to take off that unnecessary weight. Do you know that some of these engines of stationary form—the class I am condemning—weigh 600 pounds per horsepower? Think of it! And when these same engines are refined down for ship work without changing the type of structure, just the same typical arrangement, but reducing the bedplate and getting rid of flywheels, they come down to about 150 pounds per horsepower. But there they stick. To go below that it is necessary to change the structural arrangement to conform more and more nearly to the better and more refined class of standard steam practice, and in this country there are excellent models for them, and all that has to be done is to follow them out and keep within the same method of calculating loads and factors of safety—keep the same factors and the result will work just as well as in the steel. That means not only the taking away of this cast jacket and making the cylinder barrel carry the two kinds of stress—the bursting and the longitudinal at the same time, which it is perfectly able to do—but it means also to take this heavy cast iron frame structure away from the space between the cylinder end and the bedplate and to substitute for it the steel tension rod construction of the torpedo boat or yacht engine—to mention the two most highly developed forms of that structure. To be sure, that type of engine is not a stiff engine. Certainly the cylinders are going to sway and weave. But what of that? Where did these oil engine designers get the idea that this thing had to be a stiff structure, like a brick wall? I do not know where, but they got it, and there it sticks.

The most successful engines we have to-day, and the

most wonderful machines that we have ever designed, are steam locomotives. When you consider what they have to do and how well they do it, they are truly wonderful. What would happen to a locomotive that was built stiff? And what would happen to the rails on which it runs? You would have neither locomotive nor rails at the end of the first run. The steam engine that gives years and years of service and is regarded as a model of reliability, carrying a ship trip after trip back and forth across the ocean like a ferryboat, is that a stiff structure? It is not; it weaves and twists, but that does not hurt it. Why, then, should we insist upon the cast iron stiff structure for oil engines? There is no reason on earth why we should. So I say that we can take the steam engine structure from bedplate to cylinder and design and apply it to oil engines, selecting dimensions to give similar elastic factors, bearing loads and so forth, and it should give equal success.

Troubles in the Foundry

After these two changes, it will be time to remove the outside cast wall of the cylinder head. By taking the cast head jacket away from the top of the head we will free the valve housings, the intake and exhaust ports, the housing for spray valve and starting valve. These will then be exposed and the present elaborately cored casting eliminated. These cored heads are so awful the foundrymen and molders are not to be blamed for doing with them what they always do when they get into a corner with cores that are too intricate—they knock a piece off; and then we wonder why the head overheats. The designer thought he had provided for water, but the molder could not get it there, and the designer is responsible for asking a molder to do what no man could do. In proportion as that casting is made easy to mold, so it will be a good job. By means of the oxygen weld the whole cylinder head top can be left off and the only cores left are the cores for the intake and exhaust, which are easy cores. Then you get a clean casting which can be inspected on both sides and free of bad shrinkage stresses, add a sheet jacket welded around the edges and you will have a real job.

Pre-eminence of Submarine Engine

Just as an indication of what happens when this thing is carried out, even in part, I will tell you that the most highly developed of these oil engines to-day are the submarine engines. In those engines the heavy cast frame structure in the better of them has been removed, and, as a consequence of the steam engine practice as to frame structure, those engines, which in the older form of oil engine structure weighed 150 pounds, more or less, to the horsepower, have come down to what? Thirty-five pounds or 40 pounds per horsepower. They still, however, are carrying the cast iron jacket and a cast iron roof to the head, so there is room for saving some more without doing any harm whatever.

To conclude, then, with a word or two about the auxiliaries, especially with ships, because you may get a perfectly fine engine, and by wrong kinds of auxiliaries or wrong arrangement of auxiliaries have an awful hard engine room to work. The tendency for some time has been to regard the engine structure, when it comes to auxiliaries, as a sort of Christmas tree, on which you hang anything you want to use. If they decided to put a fire alarm in the engine room, I have no doubt that they would stick it on the engine somewhere. You find circulating pumps, air compressors, water pumps for circulating water, and oil pumps—in some cases bilge pumps—all hooked onto the main structure of the engine, which, in some cases and quite a number, is 2-cycle, with a row of scavenging cylinders stuck along one side, so that they resemble the old river boat engines. It certainly makes a weird combination, and in the old-day steam engine practice just that thing was done. They carried feed pumps on the engine, condensers were mounted on the engine, and hot well and circulating pumps likewise. It took us 150 years to get rid of that arrangement, and it is no longer standard practice. The engine structure should be preserved and respected as an engine structure, and not interfered with at all by hanging any kind of trimmings on it that have the slightest possibility of interfering with access to the engine. Doubly so is that true when the auxiliary attached to the engine does not and cannot behave right as attached.

Separate Control for Engine and Cooling Water

In the latter connection, I would call your attention particularly to the circulating pump for water. When the circulating pump for water is driven off the engine, either by its own crank or by rocker and links from other moving parts, then when the engine stops the water stops, and when the engine starts the water starts. That might seem to be a desirable thing at first glance. As a matter of fact, it is positively dangerous, and many cracked cylinders and piston heads can be traced to that cause alone; because, consider the interior of a cylinder when the engine is running at full power, and you will see that there are some hundred pounds of metal very hot—quite hot in proportion as it is thick. Now, when that engine is shut down, heat is there as insensible heat of the metal, and the jackets are full of water—X pound of water and Y pound of hot metal. If the weights and heats involved are figured out you will find in a big engine there is enough heat in the metal to evaporate all the water to steam and you would still have some left to conduct out to more distant parts, which should be cold—parts which are designed to be cold, but which, when hot, crack. Especially is that true when, after such a shutdown and a general heating, somebody starts the engine and shuts a lot of cold water up against the surface. That condition can be eliminated only by completely independent jacket water circulators separately driven by another engine, which permit the running of the water so long as water comes out from the discharge with any rise in temperature over the intake. In other words, the water should be continued through such an engine until it ceases to become warm, and that may be from twenty minutes to half an hour after the shutdown, depending on the size and style of machine.

A similar discussion could be carried on about other auxiliaries. This question of auxiliary arrangement and starting by an auxiliary engine is just as important for study as the engine itself. There is just as much room for improvement as in the engine structure, as a structure, or the engine parts that are concerned with its functional operation.

Getting back now to the beginning, it must be admitted, and the more you study it the more willing you will be to admit it, that, while we have made very considerable progress with the heavy oil engine, that progress is by no means ended. In fact, we can go much further yet than we have already gone, and we can make the heavy oil engine meet conditions it has heretofore failed to meet.

Shipyards allotment of 250,000 tons of steel monthly is to be reduced to 150,000 tons a month on January 1, owing to their accumulation of 1,300,000 tons of reserve stock at the yards, enough for 4,000,000 tons of shipping.

Rapid Development of the Electric Cast Steel Anchor Chain Industry*

Immediate Needs for Chain—Early Difficulties Seemed Simple—Electric Welding Versus Hand Welding—Tests and Results

BY W. L. MERRILL

AT the time our shipping programme was decided upon, it was obvious that the United States was in no position to furnish many of the items entering into the construction of ships. One item was anchor chain. The average size merchant ship requires in the neighborhood of 30 tons of anchor chain, and for a programme of 1,500 ships this item alone would run to approximately 45,000 tons of chain or over five 8,000-ton shiploads of chain. To this equipment had to be added the complement of anchors and wild cats, together with the necessary storage facilities. This in itself was no small part of the ship programme.

The anchor chain industry has for the most part been limited to foreign manufacture, as the amount of merchant marine built in recent years in this country has been practically negligible. Our navy, however, manufactured most of its chain at the Charleston Navy Yard; but as the time for building a battleship varies from three to five years it is obvious that the anchor chain could readily be produced during the interval between the time the keel is laid and the time the chain is required, since comparatively few ships have been under construction at the same time, and a ship requires not much chain.

The universal method of making chain, with one or two exceptions, has been by hand forging; and a gang of chain makers could produce but a few links each day. It therefore seemed inevitable that a new process for making anchor chain must be developed or a great army of workmen would have to be trained and facilities supplied for producing chain by the original methods.

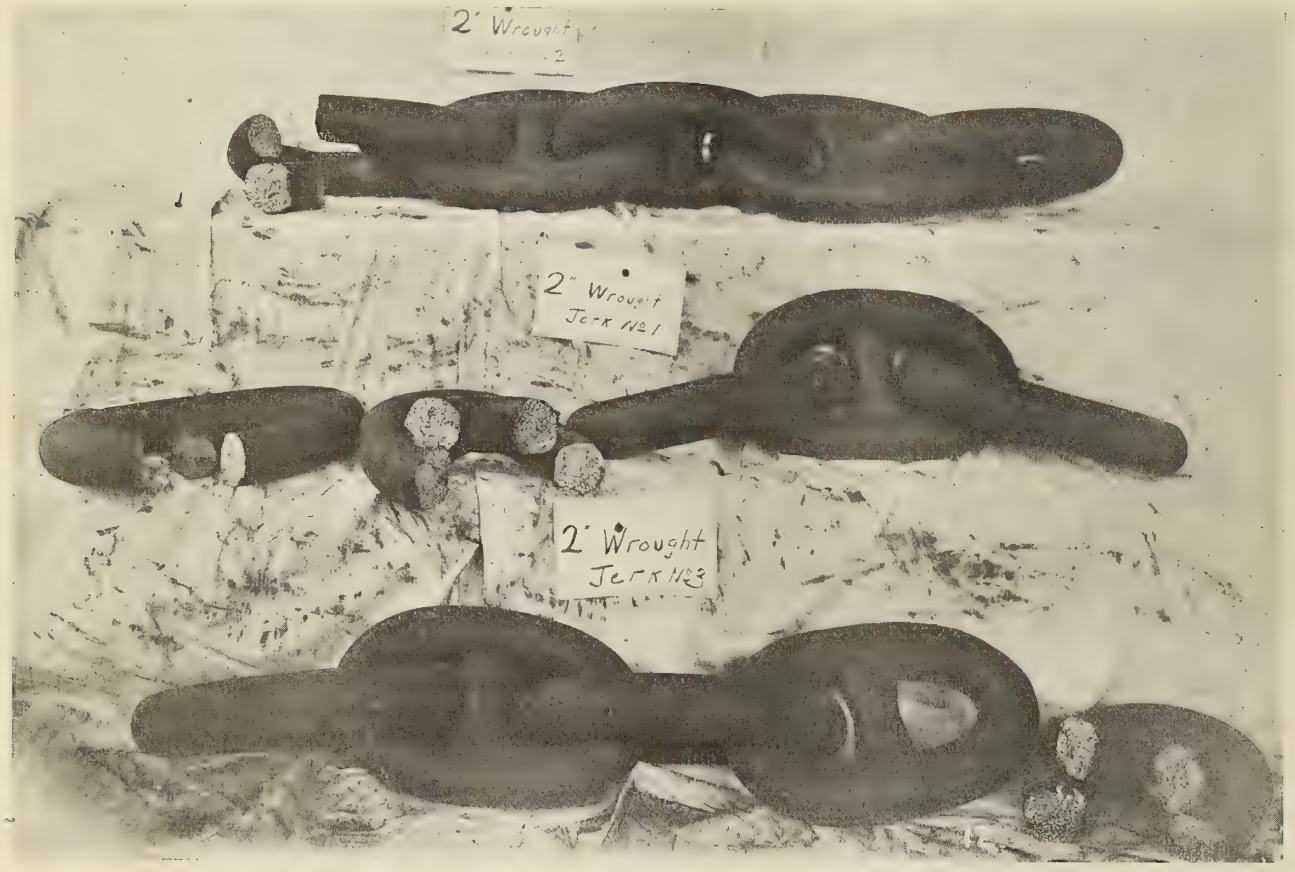


Fig. 1.—Results of Jerk Test on 2-Inch Wrought Iron Chain

To solve this dilemma, the Shipping Board appealed to the Engineering Committee of the Council of National Defense to investigate and advise the most economical method of producing anchor chain in large quantities. Accordingly, a sub-committee was appointed consisting of representatives of chain manufacturers, Navy Department, classification societies, United States Steamboat Inspection Service, and the Emergency Fleet Corporation, with the writer as chairman.

From the standpoint of an electrical engineer the problem seemed simple, as evidently the principal duty of an anchor chain was to connect an anchor at the bottom of the ocean with the bow of a ship and to have sufficient strength to keep the two in fairly close proximity to each

*Abstract of article published in *General Electric Review*.

other during storms and shore leaves of the crew when in friendly ports. However, the factor of strength did not prove to be of primary importance when considered from the nautical viewpoint. The weight of chain per fathom for a given size ship was the important requirement, and this is obvious when the action of the chain with the ship riding at anchor in a heavy seaway is considered. As-

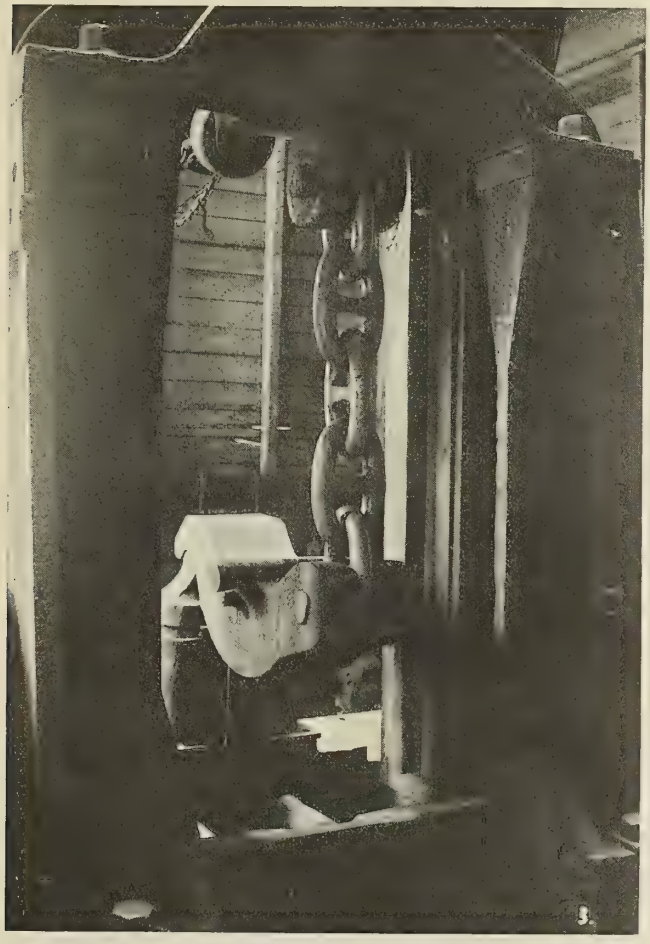


Fig. 2.—Chain Subjected to Jerk Test

sume, for instance, that it is possible to have a thin wire of a strength equal to that of the anchor chain for a certain ship; it is evident that when the ship heads into the wind with the bow in the trough of the sea the next wave coming will raise the ship, which action will result in the wire breaking or dragging the anchor. Therefore, it will be seen that weight per fathom of chain is a very important factor, and investigation has shown that chain of sufficient weight for a given ship will, if properly made of a good material, have sufficient strength.

One of the first investigations carried on by the committee was to consider the substitution of electric welding for hand welding of chain. This was successfully done. However, as in the hand process of welding and in the machine forging process, as used at the Charleston Navy Yard, it simply speeded up but one of a number of operations necessary to produce the chain.

It was then decided that, whatever be the process of welding the chain, at least every other link could be drop-forged to shape, including the stud, and the alternate link could be welded by hand, machine or electrically. A set of dies for 2-inch chain was accordingly made at the Schenectady works of the General Electric Company and a number of links were forged. Tests showed them to be successful. It was thought that the Fleet Corporation would be able to obtain drop hammers in various parts of the country, order links forged from cast ingots and have the links shipped to chain shops, where they could be welded in the finished chain, thereby materially reducing the labor on half of the production. This method would not particularly adapt itself to the heavier chains, as it is much easier for a chain maker to weld a link at the end of a chain than to connect two pieces of chain together; and, while it would have undoubtedly speeded up the production of chain, on the whole it would have handicapped that part of the process in which hand welding would be employed.

From the foregoing it appeared that any process for making chain which would make a real reduction in the over-all labor must be some radical change from the conventional methods, particularly eliminating the preparation of the material for the chain, the hand method requiring—starting with pig iron—melting down, puddling, squeezing, rolling ingots into bars, cutting bars, bending links, scarfing for the welds, welding, inserting stud.

For each operation in bringing the link to shape, repeated heating is necessary. It appeared that to turn out the amount of chain required by the Shipping Board in the time estimated the hand method would have required more man-hours and weight of equipment to produce the furnaces, machinery, etc., than it would to produce the chain itself.

In 1911 the Marion Steam Shovel Company had occasion to build some chain for dredge work, the links being 36 inches long and the wire 7½ inches in diameter. This was made by casting one link at a time with the molds interlocked. This chain was entirely successful and is in service to-day. It occurred to the writer that it might be possible to cast much smaller chain than this by the use of

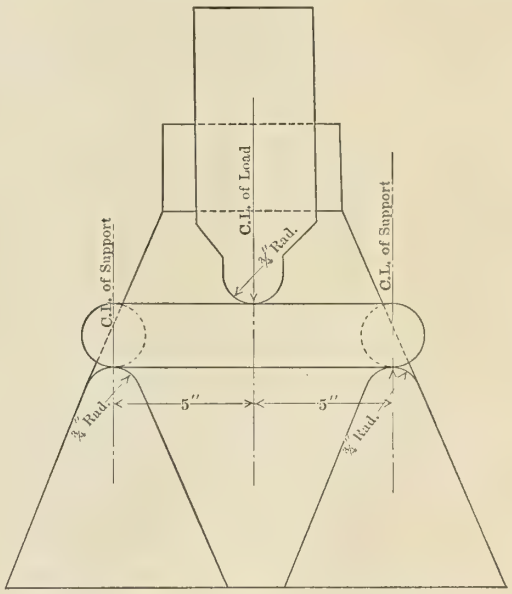


Fig. 3.—Transverse Bending Test

electric steel. Accordingly, samples were made in the Schenectady works which proved that successful chain could be made by this process. The first attempt was made by die-casting the links, with the studs afterwards placed in position, the same as in hand welded chain. It was found, however, that while it was possible to make die-cast chain from electric steel it was not feasible for a large production, since there is a very critical time at which the molds should be opened to prevent shrinkage cracks; and if opened too soon, the metal, of course, would not be

congealed. Therefore, dry sand molds were resorted to and successful chain was made by this method.

The classification societies' requirements for 2-inch chain are as follows:

Breaking test.....225,792 pounds
Proof test.....161,280 pounds

It was decided at this time to extend the activities of this investigation and methods of casting. Consequently, the National Malleable Castings Company was interested in

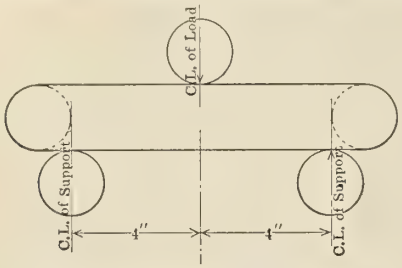


Fig. 4.—Showing Diameters of Load and of Support Bearings

making sample electric steel chain. The E. H. Mumford Company was asked to investigate automatic machinery for producing molds. Those companies worked up a process for molding chain in sections complete with the studs cast as a part of the link, and successful chain was made by this process in several foundries. The National Malleable Castings Company then made chain in various sizes from 1⅜ inches to 2⅞ inches, the 1⅜-inch link apparently being the smallest that it is at present practicable to mold. Tests were then carried on at their plant with various samples of chain which they had cast, in comparison with hand-wrought chain and navy chain from the Charleston Navy Yard. These tests consisted of tensile tests and shock tests in a standard MCB machine. In all cases the electric steel chain showed greater tensile strength and stood more punishment in the drop test than the wrought chain.

Further tests were made at the National Malleable Casting Company's plant to get comparative data and specifications on a shock bending test.

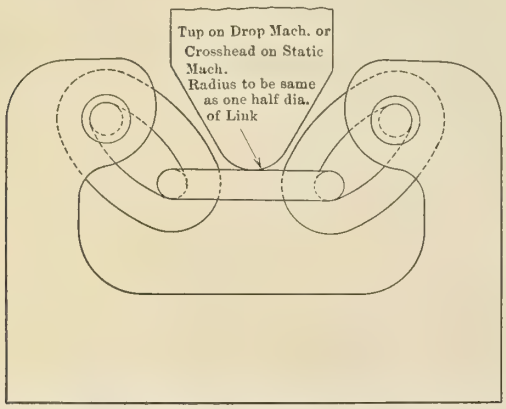


Fig. 5.—Diagram Showing Chain Support

There are no requirements for elongation or reduction in area. Our first samples tested at the Bureau of Standards were nearly double the strength of wrought chain, and it was felt by some members of the committee that this was the solution of the chain problem. Other members felt that further tests would be necessary before adopting cast steel chain, and seemed to be much exercised about the comparative corrodible quality of electric steel and wrought iron. But, there being no reliable data available on wrought chain, it was felt that the life of electric steel chain in comparison would at least last during the present emergency, and therefore the question of corrosion was dismissed. Nor was it again brought up for consideration.

As a result of this work, the American Bureau of Shipping and Lloyds have approved and issued specifications permitting the use of electric steel anchor chain on ship-

Fig. 6.—Results of Static Test

Fig. 7.—Machine for Making Static Test

board, these specifications differing in the main from those for wrought chain in the following points:

The original breaking test of wrought chain is now specified for the proof test with proportional increase in tests for sample links above this of 40 percent. For example, the original proof tests of 2-inch chain, 161,280 pounds; for electric steel, 225,972 pounds. The original breaking test for wrought chain, 225,792 pounds; for cast steel, 316,109 pounds. To this is added a shock bending test for sample links as mentioned above.

How the Tests Were Conducted

When we consider the method of making anchor chain a year ago and follow the ore from the mine to the finished product and compare it with the electric steel method, we must realize that, first, better chain can be produced; second, tremendous economy can be secured in the conservation of man-hours, machinery, fuel, and transportation. The conservative estimate of a foundry equipped with an open hearth for melting down and a 10-ton electric furnace for refining should produce 70 tons of finished chain each 24 hours, based on a 2-inch average size. Practically no skilled labor is required, outside of that for supervision.

The tests which follow were conducted in a static test machine of 1,000,000 pounds capacity and a standard master car builder's drop test machine.

Two kinds of tests were made in the static machine. The first consisted of supporting separate 2-inch links on

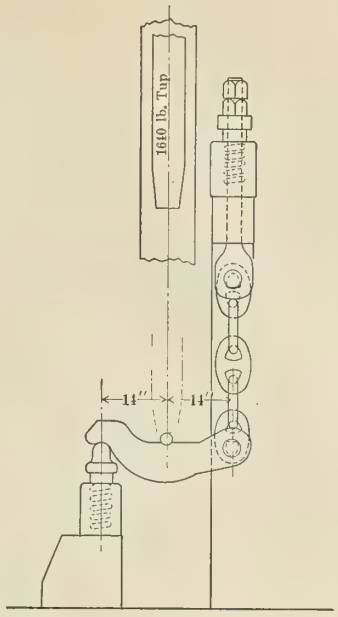
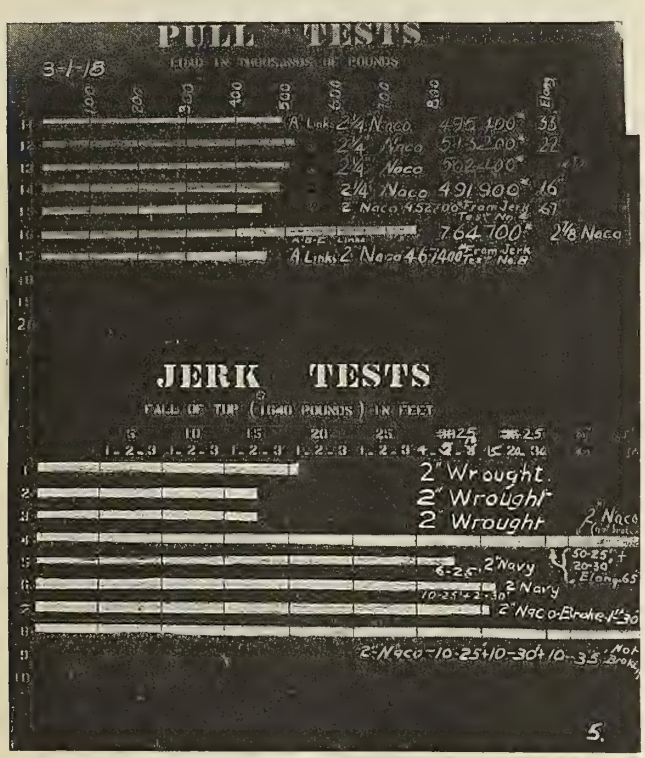


Fig. 9.—Diagram of Jerk Test Machine

position by supporting the upper link in a shackle bar and the lower link in an equalizer bar by means of shackle pins and in such a manner that one-half the energy developed from the falling tup will be imposed upon the chain thus suspended and in the form of a dynamic jerk.

The second kind of drop test was conducted on separate common "A" links by supporting the link in a standard MCB knuckle pin test block. In this case the supports were ¾-inch radius and 10 inches center to center and the dynamic load was applied transversely at the center of the link, through a plunger having a ¾-inch radius at its nose.

For convenience, we will classify these various tests



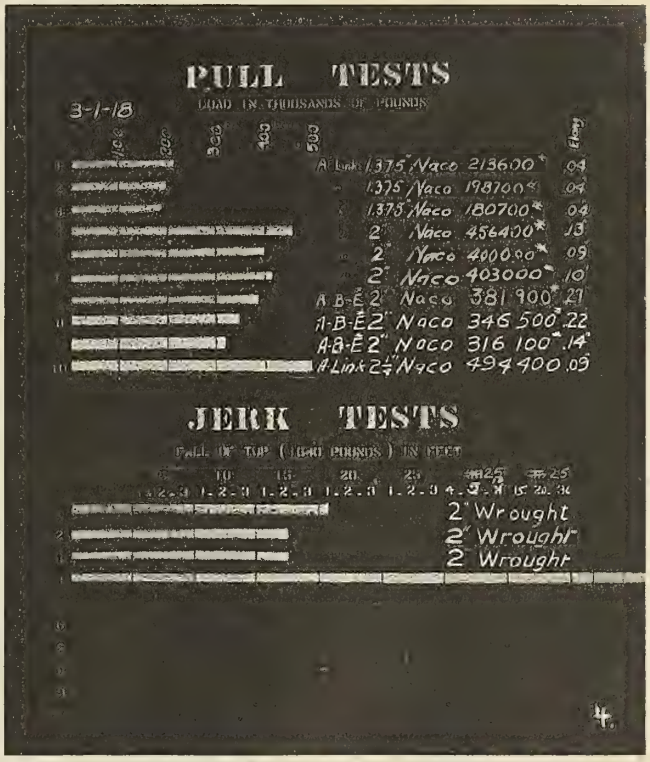


Fig. 8.—Results of Wrought and Cast Iron Tests in Both Pull and Jerk Machines

2-inch round pins spaced 8 inches from center to center. A third 2-inch round pin was placed transversely across the link at its center and the load applied on this link.

The second test consisted of supporting a 2-inch chain consisting of three common "A" links in a frame and applying the static load at the center of the middle link.

Two kinds of tests were also conducted in the drop test machine. The first kind consisted of supporting a 2-inch chain consisting of five common "A" links in a vertical

into groups, according to the kind of test made. Group No. 1 will embody the transverse tests conducted on separate common "A" links in the static test machine. Test group No. 2 will embody the tests conducted on the three-link chain in the static test machine. Test group No. 3 will embody the transverse tests conducted on separate links in the drop test machine. Test group No. 4 will embody tests conducted on five-link chains in the drop test machine.

REPORT ON ANCHOR CHAIN TESTS

TEST GROUP NO. 1.

Wrought iron link supported 8-inch centers.

Test No. 1.

Load.	*Deflection.*
25,000 pounds	0.00 inch
50,000 "	0.01 "
75,000 "	0.06 "
100,000 "	0.33 "
125,000 "	0.83 "
145,000 "	1.66 "

Support pins slipped from under the link at 145,000 pounds load. Total number of degrees through which link bent 53.5.

"Naco" steel link supported 8-inch centers.

Test No. 2.

Load.	*Deflection.*
145,000 pounds	0.00 inch
161,000 "	0.01 "
225,000 "	0.17 "

Fractured one side of link close to stud at load of 237,300 pounds. Test continued and fractured remaining side at 145,000 pounds load. Section of metal through fracture shows solid.

TEST GROUP NO. 2.

Wrought iron three-inch chain—static test.

Test No. 3: Center link fractured through end at 278,500 pounds load.
Test No. 4: Center link fractured through end at 237,500 pounds load.
Test No. 5: Center link fractured through end and side at 230,900 pounds load.

Naco steel—three-link chain—static test.

Test No. 6: Center link fractured through one side at 209,000 pounds load. Test continued and fractured remaining side at 93,800 pounds load.
Test No. 7: Center link fractured through one side at 231,400 pounds load.
Test No. 8: Center link fractured through one side at 210,000 pounds load.

TEST GROUP NO. 3.

Separate link supported in M. C. B. pin test block. Weight of Tup 1,640 pounds.

Test No.	*Material.*	*Fall of Tup.*	*Deflection.*	*Remarks.*
9	Wrought	6 feet	21 degrees	No fractures
10	"	7 "	32 "	" "
11	"	8 "	.. "	Link broke
12	"	8 "	36 "	No fractures
13	Naco	8 "	11 "	" "
14	"	8 "	12 "	" "
15	"	10 "	Not measured	Link broke 2nd blow at 10 ft.
16	"	12 "	..	Link broke.

TEST GROUP NO. 4.

Test No. 17: Wrought iron 5-link chain.
3 blows of 1640 pounds falling 5 feet.....chain O. K.
1 blow of 1640 pounds falling 10 feet.....chain broke.

Test No. 18: Wrought iron 5-link chain.
3 blows of 1,640 pounds falling 5 feet.....chain O. K.
3 " of 1,640 pounds " 10 feet..... " "
3 " of 1,640 pounds " 15 feet..... " "
2 " of 1,640 pounds " 20 feet..... " broke.

Test No. 19 Naco" steel 5-link chain.
3 blows of 1,640 pounds falling 5 feet.....chain O. K.
3 " of 1,640 pounds " 10 feet..... "
3 " of 1,640 pounds " 15 feet..... " "
3 " of 1,640 pounds " 20 feet..... " "
3 " of 1,640 pounds " 25 feet..... " "
3 " of 1,640 pounds " 30 feet..... " "
3 " of 1,640 pounds " 35 feet..... " "

Test discontinued after 3 blows at 35 feet with no apparent distortion or destruction of any one of the links.

Shipbuilding Costs and Estimates—I*

The Human Element a Large Factor—"News" and Not "History" Constitutes a Good Costing System

BY JAMES M. ROBERTSON

COSTING is a system of recording results of work done so that a firm is able to tell: (1) The cost of producing any article made, and (2) the result of any operation.

Cost accounts deal entirely with the practical side of an industrial concern; any tendency towards their being mixed up with the general bookkeeping records of a company should at once be eliminated, as it only leads to delays and all sorts of complications. The figures in the two sets of accounts should agree, and the different books fit in sufficiently to permit of the totals being checked.

Briefly, the chief difference between cost and ledger accounts is that, while costing aims or endeavors to arrive at the net results of manufacturing by analysis—that is, to show what it costs to produce any specific item of work—the commercial accounts group together the results, not of each manufacturing process, but of each class of expenditures. The financial books will record the incomings and outgoings of cash and material over a given period, but the cost books, by analysis and grouping, will show the value of each important section of work done.

Generally, lines of organization rather than similarity of products, provide the best basis for a cost accounting system. Industries are, therefore, classified in this way and methods indicated which are applicable to particular businesses along these lines. Cost accounts are under two broad divisions—the *first* aims at ascertaining profit or loss on each particular contract; and the *second* ascertains how the cost of producing a commodity compares with its market price, both items being of a fluctuating character.

In operation, the above systems vary considerably. In small concerns, or where the detailed information required is of a limited character, the costing accounts are simple and the work demands little skill. In other undertakings, however, costing may be quite an elaborate business, requiring considerable skill and technical knowledge of the work if fallacious results are to be avoided.

A good cost system should be: (1) Simple in design and economical in its operation; (2) reliable in its methods and clear in its results, and (3) arranged so that records will be kept up to date.

What is wanted is to aim at a system which will secure, with the minimum of well-directed work, the most reliable results.

Cost accounts should be so arranged as to be easily followed by any man conversant with the business. Over-elaboration of detail must be guarded against and care taken that the value of the results obtained are in proportion to the labor spent in getting them. The system should not come under the reproach that more money is spent finding out what the article costs than in making it. On the other hand, it should be recognized that the less detail a firm keeps, the more dependent does it become in its search for new work upon a particular member of the staff.

As the human element is a very large factor in the success of any system, and the men working it may not be always so thoughtful and analytical as one might expect, it is very necessary that the methods adopted should be reliable and the results clear.

It has been said that a good costing system should supply "news" and not "history." Any system in which the records are not kept up to date with totals readily available loses quite half its usefulness. Comparisons with past results are continually required, and directors are often unsympathetic toward costing, largely because, as a rule, information is rarely available at the time it is wanted, and when produced later is of little use, since the occasion which called for it has passed. Again, if the accuracy of the final figures is to be assured, these should be compiled as quickly as possible after the contract is completed, so that any errors may be rectified while the work is fresh in the minds of all concerned.

* Abstract of a paper read before the Greenock Society of Shipbuilders and Engineers.

A good cost keeper should possess: (1) Speed and accuracy; (2) technical knowledge of the business, and (3) perspective.

As previously mentioned, since comparisons of present with past results are continually required, usually at very short notice, leaving little time available for checks, the need for speed and accuracy is obvious.

Possession of the second qualification is very desirable, otherwise stupid mistakes are likely to occur. A mere name knowledge of the articles produced is not sufficient to ensure correct records. This usually indicates that costing is being done in a routine fashion without thought or interest. When a man suggests a credit for waterways because he knows launchways have been credited, or extends two steel H.P. as two horsepower instead of two hawsepipes, or charges plates weighing 40 pounds per square foot against a destroyer's cost, and sees nothing wrong, then the need of technical knowledge is evident.

The possession, or the cultivation, of the faculty of perspective by men engaged in costing will go a long way toward ensuring the efficiency of any system. The ability to know how much time and labor may reasonably be spent in compiling records in relation to their ultimate value cannot be overestimated. A system may owe its success or failure to the presence or absence of this qualification in its working. The chances are that where the money spent on costing is out of proportion to the value of the records obtained, it is not so much a defect in the system as lack of perspective on the part of those responsible for carrying out the work.

Advantages of a Good Costing System

A good costing system enables detailed comparisons to be made between the estimated and the actual cost of contracts, as well as between past and present results and output of work in each trade; it encourages greater all-round efficiency in working by showing where output may be increased and production cheapened; it forms a basis for estimating.

How to Get the Best Results From a Costing System

As far as possible costing work should be made self-contained and independent of any outside department for its data.

The work should be arranged to be as interesting as possible.

In many firms costing is in the hands of one man, with possibly an assistant to help him. The duties are practically limited to the collection of figures from other departments and their allocation against the respective cost divisions.

While it is recognized that in small concerns it may not be possible to depart to any great extent from the above method, still such a system rarely gives the best results. Such an arrangement makes the costing department too dependent on other departments, which are often unsympathetic with the aims and objects of costing, for figures. Much of the cost-keeper's work accordingly becomes uninteresting and mechanical.

Where possible it is advisable to make all clerks handling material for vessels cost clerks. A man should have a section of the work, one, two or more trades to look after, according to the size of the concern and the extent of its output. He should carry through practically all the work—pricing, abstracting and unimportant correspondence regarding tenders and delivery, as well as be responsible for the stock. Under the supervision of a responsible head cost clerk the work of subordinates is thus made more complete, variable and interesting, and better final results are likely to be obtained.

In the past there has been too much secrecy about methods of cost keeping in shipbuilding. While it is in order to keep the result of the actual workings of a firm secret, yet it would be to the advantage of the industry if all shipyards had a fairly detailed costing system in operation. If some standard system could be adopted whereby all came into line in their methods of charging material and labor, and dealing with establishment charges, shipbuilding would benefit. Much undue competition for new work would thereby be eliminated, as the firm that contracts for new work at a ridiculously low figure to its later regret is not as a rule the one in possession of the best costing system.

Shipbuilding Cost Accounts

A separate account for each contract is kept so that the profit or loss can be readily ascertained, while over and above this a detailed analysis of all work done and material supplied is kept in a suitably arranged form. Shipbuilding is too extensive in its operations to lend itself to the same accuracy of costs as are associated with certain other manufacturing concerns. This fact should be recognized and efforts made to strictly limit probable errors without an undue expenditure of time and labor. As values and quantities are usually large, a small percentage of error in no way detracts from the value of the costs.

Material

The first subdivision of the material naturally falls under that of trades, and lump-sum figures are available at the completion of a contract showing the respective trade costs. These broad divisions are further subdivided usually on a job basis according to plan, and lists are issued to the drawing office and all other departments concerned. Costs of every important section of work done by each trade are thus arrived at.

The proportion of material purchased for purely stock purposes is generally very small. As far as possible all material is specified against particular work in hand, and debited direct to the ship when invoiced. However, certain materials, such as rivets, hardware, electrical fittings, paints, timber, etc., do not readily lend themselves to direct charging, as they can only be ordered in approximate quantities for each ship.

To ensure greater accuracy and avoid possible credits or debits at the completion of the vessel it is better to debit this material to a stock or store account, and have it charged against the ship when requisitioned for her by an order from the foremen, the store account being then credited with the amount. All material ordered is usually according to specification received from the drawing office, which should mark thereon the job and cost division number it is to be charged against.

The figures for the issues from stores should be posted fortnightly or monthly from separate books and should be checked with ledger figures. These separate books should contain suitable summaries of value of material charged through store sheets.

Detailed particulars of the material charged direct should be available in suitable form. Hull castings (or forgings) include: Stem, stern-post, propeller brackets, rudder frame, etc. Deck machinery includes: Winches, cranes, windlass, capstan, steering gear, refrigerating and electric plants, disinfector, etc. Outfit, etc., includes: Anchors and cables, upholstery, boats, cooking gear, lamps, chandlery, nautical instruments, canvas gear, hawsers and reels, etc. Sundry cash items include: Classification fees, passenger certificate, hull insurance, towage, cranage, dock dues, purveying at trial, freight, etc.

Work is usually done under one of two wage-payment systems—time rate or piecework. While it is not so difficult to get a record of jobs done on piece as on time, yet the importance of accuracy in allocating jobs against their respective classification number is not generally and fully recognized. When one considers the time and labor spent in compiling data it is surely false economy to adopt any other than the best possible measures to ensure that work be correctly charged.

The best results are usually obtained by a timekeeper going among the men at least once a day and taking a record of their work. If possible a tradesman thoroughly conversant with the work should be employed. If the interest and sympathy of the foreman can be enlisted to roughly scrutinize the allocation of work done, then greater accuracy will be ensured. As far as possible job classification numbers should be standardized so as to repeat themselves and stand for the same section of work in successive vessels.

The extra hours paid to men when employed after hours over and above those actually worked should be kept under a separate acceleration number and charged as a "breakage" to cost of vessel.

Establishment Charges

Establishment charges embrace expenditures incurred in: (a) The necessary carrying on of a business; (b) increasing the production power of labor; and the particular items of outlay, which in each case cannot be readily allocated directly against work in progress. Among other things this "oncost," as it is sometimes called, should cover depreciation, obsolescence and certain capital risks, but not remuneration on capital invested in the business.

So far as shipyards are concerned, the labor basis commonly in use, though not by any means accurate, may be taken on the whole as the best. It has the merit of simplicity in its favor, and it certainly enables the estimator to deal with this part of his work readily. In allocating charges over actual costs, however, some discrimination might be made between the wages paid to purely hand workers on board a vessel at a fitting out basin and men employed in the works using space, plant and power.

While the allocation of charges on a labor basis appears on the whole satisfactory, some further division of charges would seem necessary. A firm should know what proportion the irreducible part of its cost bears to the total.

Fixed and Fluctuating Charges

The practically fixed portion of the costs would include such items as rent, rates and taxes, general management expenses, office salaries, building repairs, depreciation and sundry expenses.

The fluctuating portion moves broadly in harmony with output and would include plant repairs and renewals; electric current and power, coal, coke and gas, fuel oils, naphtha, gasoline (petrol), oxygen, drillers' grease, wages of storemen, winchmen, cranemen and stationery.

The benefit of this division between fixed and fluctuating charges becomes apparent if a firm has to cut in very keenly for work. Assuming the net cost without profit of a ship at $475,000 (£100,000), of which $95,000 (£20,000) is charges—$33,250 (£7,000) of this $95,000 (£20,000) is fluctuating, and the balance $61,750 (£13,000) is fixed, charges. At a push it may pay a firm to accept, rather than decline, this order at, say, $441,750 (£93,000), as by so doing they receive the direct cost of material and labor, viz., $380,000 (£80,000), plus the $33,250 (£7,000) fluctuating on cost, plus $28,500 (£6,000) towards the reduction of their fixed charges, which are running on whether they get work or not.

The question of charges does not as a rule come under the review of the average shipbuilding costing department. Their work is usually limited to prime cost, i. e., dealing with material and labor only. It is suggested that a firm might with advantage consider the advisability of bringing this work more within the scope of costing, with a view to keeping a better record of its incidence and securing a more equitable distribution of its totals over the work done. The following summary of items which it is considered are best dealt with in charges may be useful:

Items Suggested To Be Included in Establishment Charges

The Use of: Buildings, berths, machinery, yard, cranes, derricks and gear, uprights, shores, stage planks, keel blocks, launching gear, small tools, bolts and wedges.

Power for and Use of: Acetylene, hydraulic, electric and pneumatic plants.

Salaries and Wages: Officials, clerks, typists, yard engineers, machinemen, electricians, laborers, watchmen, furnacemen, gatemen, storekeepers, timekeepers, messengers and attendants.

Cost of: Rent, feu duties, rates, taxes, gas, electric light and power, naphtha, lubricating and fuel oils, drillers' grease, gasoline (petrol) for blow-lamps, yard insurance, office cleaning and purveying, D. O. material, data and records, coal and coke, waste, stationery, packing materials, telephones, telegrams, postages, advertising and charities.

Suggested that: Employers' liability and national insurances be debited either monthly or quarterly direct to the vessel, under material, as a percentage on wages spent.

To sum up, it is held that a cost system should be considered an investment and not an expense. No claim is made that cost accounts will in themselves cure inefficiency in management or permit a concern being run without a manager, or save a business from failure. It is contended, however, that the system will supply real live information which, if properly used, will do much to promote and aid efficiency; while a firm which knows actually where it stands from week to week is much less likely to become bankrupt than one which is directed during the year by guesswork.

(To be concluded.)

Lengthening Ships to Increase Their Capacity

"It occurs to me that there must be a good many steamships whose speed would be improved by lengthening them besides increasing their carrying capacity at the same time," writes a foreign contributor in a recent issue of the *Scientific American*. "The cutting of the hull and the rejoining of it to the additional length would be a job for a dry dock and a shipbuilder. But the lengthening section could be fabricated in any bridge builder's or boiler maker's yard. If a knot an hour and a five percent or ten percent increase of carrying capacity could be got at one and the same time it would seem that in this way (applied to ships whose lines show that lengthening would increase their speed) the greatest advantage would be taken of existing vessels, expert builders and 'fabricators.' Cutting a hull is a matter of hours. The 'fabricators' would 'get their hands in' on that part of a ship, which might be turned out by a rolling mill and sold by the yard, for all the change in cross section that occurs is in 50 feet of it. Given suitable existing ships, I do not think any quicker way of effecting an increase in tonnage exists, with the means at your disposal."

Investigation of Shearing Force and Bending Moment on Ship Structures*—II

Moderate Amplitudes of Heave—The Sagging Bending Moment—Pitching Treated Graphically—Effect of Rotational Acceleration

BY A. M. ROBB, B. SC.

SHEARING force and bending moment curves, *including* the effect of heaving, obtained in the manner previously outlined, are shown in Figs. 4 and 5. Fig. 4 is for the vessel in the "standard hogging" condition of loading heaved 4.95 feet out of the wave crest, the reduction in buoyancy being about 32 percent. Fig. 5 is for the vessel in the "standard sagging" condition of loading heaved 5.11 feet into the wave trough, the increase of buoyancy being about 32 percent. For comparative purposes, the corresponding statical curves are shown on the same base lines as the "heaved" curves.

The reasons underlying the choice of amplitudes of heave are outlined in an appendix. It is not suggested that such values are ever realized in practice; but data on the subject are very scant; the only information of value that has been traced is contained in Mr. Stromeyer's contribution to the discussion on Professor Jenkins' 1890 paper where he refers to a weight suspended from a spring balance in a heaving ship showing readings 10 percent above and below the normal.

Alteration of Weight and Bending Moment

In Professor Jenkins' words: "The consideration which governs this question of increase or decrease of the bending moment is one entirely of the relative longitudinal positions of the center of gravity of the fore or after body of the vessel, and of the layer of water which is additionally immersed or emerged." Considering the portion of the ship aft of the position of maximum bending moment, it is seen that the "virtual" alteration of weight acts in the same lines as the normal weight; for moderate amplitudes of heave the alteration in buoyancy must act in a vertical line very near to the line of action of the normal buoyancy. Thus it naturally follows that the percentage alteration of bending moment due to heaving cannot be widely different from the percentage alteration of displacement. This is not actually borne out by the results given in Figs. 4 and 5. For the "standard hogging" condition the percentage reduction of bending moment is about 20, corresponding to a percentage reduction of displacement of 32; for the "standard sagging" condition the percentage increase of bending moment is about 13, corresponding to a percentage increase of displacement of 32. But it should be borne in mind that the amounts of heave adopted in the determination of Figs. 4 and 5 are probably excessive. It is reasonable to infer that for moderate amounts of heave the center of buoyancy of the layer is farther from amidships than the center of buoyancy of the fore or after bodies in the hogging condition, and nearer amidships than the center of buoyancy of the fore or after bodies in the sagging condition; so it is a further inference that the percentage variation in bending moment due to heaving is slightly less than the percentage variation in displacement.

A noteworthy point which emerges from this consideration of heaving effects is that the sagging bending moment *including* heaving is not nearly so large as the statical hogging moment, the respective values being 74,000 foot-tons and 27,000 foot-tons. Such a result is quite to be expected in the case of an ordinary merchant steamer. In four cases of intermediate type vessels examined, the ratios of maximum sagging moment to maximum hogging moment, statical, ranged from 1 : 1.4 to 1 : 2.1. Obviously,

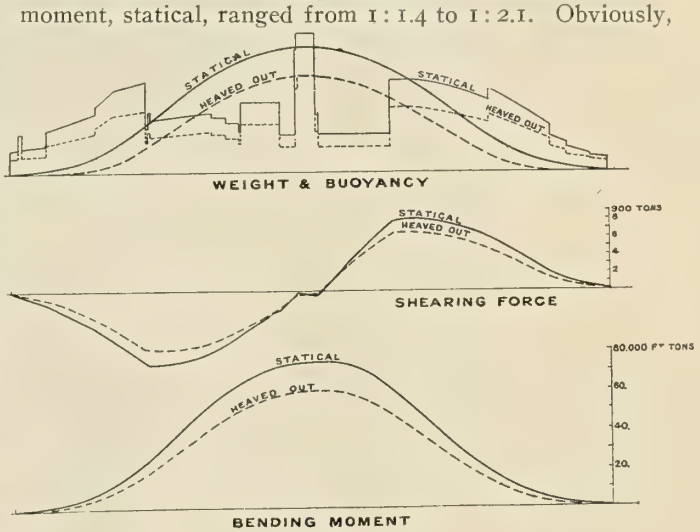


Fig. 4

no reasonable amount of heave would in any of these cases bring the sagging moment up to equality with the hogging moment. On the other hand, in the cases of a Channel steamer and a fast liner, the maximum statical hogging and sagging moments were found to be approximately equal. In such cases, the effect of heaving would be to make the sagging moments quite considerably larger

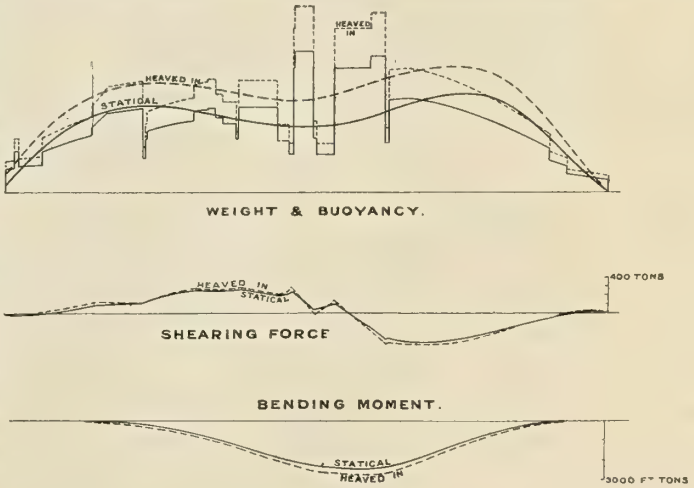


Fig. 5

than the hogging moments. But in vessels which have not large machinery weights concentrated amidships, it would seem safe to leave the effect of heaving entirely

* From a paper read at the spring meetings of the fifty-ninth session of the Institution of Naval Architects, London, March 22, 1918.

out of account, and, in fact, to make the statical hogging calculation basis of longitudinal strength considerations.

The case of pitching can be treated graphically similarly to that of heaving.

In this case it is assumed that pitching motion can exist independently of heaving motion; in other words, it is assumed that a vessel can traverse a series of waves in such a manner that, while the displacement remains the same, the position of the center of buoyancy is continually varying.

The consideration of the effect of pitching motion is very similar to the consideration of the effect of heaving

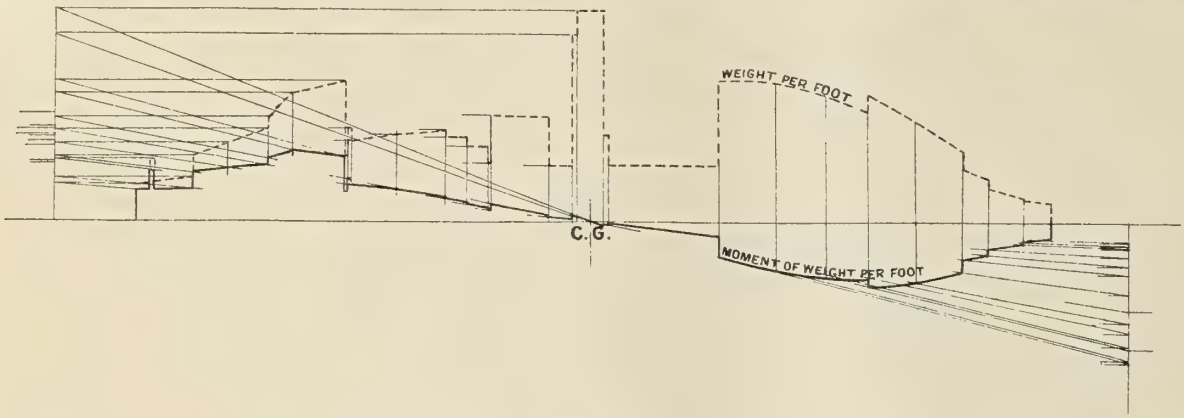


Fig. 6

motion, the rotational acceleration, alternately clockwise and anti-clockwise, of the pitching motion corresponding to the vertical acceleration, alternately upwards and downwards, of the heaving motion. A very close analogy between the two motions is obtained if, for each short length of the ship, the rotational acceleration be converted into a linear acceleration; for example, if the rotational acceleration is

$$\frac{d^2\theta}{dt^2},$$

the linear acceleration at a distance $\pm r$ from the axis of

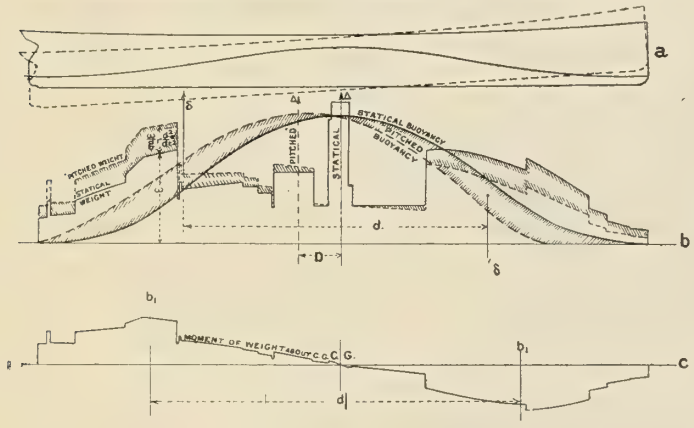


Fig. 7

rotation, assumed to be at the center of gravity, is

$$\pm r \cdot \frac{d^2\theta}{dt^2}.$$

Thus in the case of pitching there is also, in effect, vertical acceleration, but in one end of the ship it is upwards when in the other it is downwards, and vice versa. As in the case of heaving, a downward acceleration is accompanied by a "virtual" decrease in weight, an upward acceleration by a "virtual" increase of weight. For example, when the bow is "pitched" out of the water the acceleration acts downwards over the forward portion of the ship, and the weight of that portion is "virtually" decreased; at the same time the acceleration is upwards over the after portion of the ship, so that its weight is "virtually" increased. The "virtual" alteration in weight at any point is expressed by

$$\pm \frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2},$$

w being the normal weight at that point, and r its distance from the center of gravity; the plus sign is used if the part considered is "pitched" into the water, the minus sign if "pitched" out of the water. The acceleration

$$\frac{d^2\theta}{dt^2}$$

is the same along the length of the ship, and g is a constant; therefore, the "virtual" alteration in weight is proportional simply to $w \cdot r$, and so is proportional to the moment of weight about the center of gravity.

The effect of the rotational acceleration is that the distribution of the "virtual" weight varies, and so the center of gravity "virtually" oscillates about its statical position, being aft of that position when the stern is "pitched" into

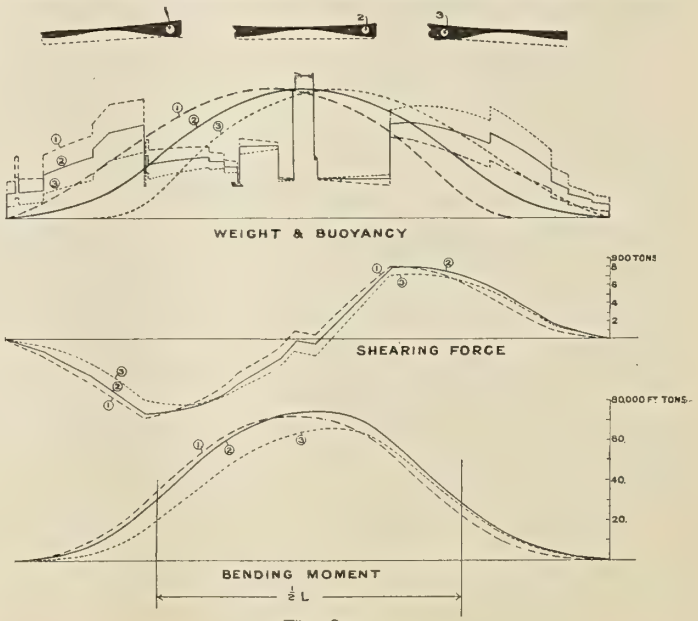


Fig. 8

the water, and forward of it when the bow is "pitched" into the water. Since by assumption the displacement remains constant, the weight also remains constant. Con-

trasting the cases of heaving and pitching, it is seen that in the first case there is a variation in weight and buoyancy, the fore-and-aft position of the center of gravity being unchanged; in the second case there is a variation in the fore-and-aft positions of the centers of gravity and buoyancy, the weight and buoyancy being unchanged.

The investigation of the effect of pitching upon shearing force and bending moment involves the use of a curve of moment of weight per foot of length about center of gravity. A very neat method of obtaining this curve has been outlined by F. H. Alexander in the appendix to his paper on "The Influence of Longitudinal Distribution of Weight Upon the Bending Moments of Ships Among Waves," read before the Institution in 1911. An example of the method is given in Fig. 6.

To obtain the curves of shearing force and bending moments it is necessary to obtain a curve of virtual weight.

Referring to Fig. 7, diagram (a), the solid lines show a vessel in statical equilibrium on the crest of a wave; the dotted lines represent the vessel "pitched" through an angle of four degrees, the displacement remaining constant. As a result of the "pitch," a wedge of buoyancy is transferred from the fore body to the after body. Let the moment of transference of buoyancy equal m. This is determined by taking the product of the displacement into the shift of the center of buoyancy; for example, referring to diagram (b), $m = \Delta \times D$; alternately, $m = \delta \times d$, δ being the displacement of either wedge, and d the distance apart of the centers of buoyancy of the immersed and emerged wedges. The acceleration, clockwise in this case, is given by

$$\frac{W}{g} \cdot k^2 \cdot \frac{d^2\theta}{dt^2} = m,$$

and

$$\frac{d^2\theta}{dt^2} = \frac{m \cdot g}{W \cdot k^2},$$

where k is the radius of gyration of the mass of the ship about the center of gravity.

The moment of inertia of the mass of the ship, and so the radius of gyration, can be determined from the second integral of the moment of weight curve. From this it is possible to evaluate

$$\frac{d^2\theta}{dt^2}.$$

Actually, however, it is not necessary to evaluate

$$\frac{d^2\theta}{dt^2}.$$

It has been seen that, on account of the rotational acceleration, any element of weight w is subject to an addition

$$\pm \frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2}.$$

The moment of the addition about the center of gravity is

$$\left(\pm \frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2}\right) \times (\pm r), \text{ or } \frac{w}{g} \cdot r^2 \cdot \frac{d^2\theta}{dt^2}.$$

Hence the total moment causing the "virtual" shift of the center of gravity is

$$\Sigma\left[\frac{w}{g} \cdot r^2 \cdot \frac{d^2\theta}{dt^2}, \text{ or } \frac{W}{g} \cdot k^2 \cdot \frac{d^2\theta}{dt^2}.\right]$$

This quantity is equal to the moment of transference of buoyancy. Thus it is seen that during the pitching motion the "virtual" center of gravity is always in the same vertical line as the "pitched" center of buoyancy. Accordingly, it is necessary to alter each ordinate of the weight curve by an amount representing

$$\frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2},$$

under the condition that the effect of the alteration is to bring the "virtual" center of gravity into the same vertical lines as the "pitched" center of buoyancy.

Referring again to Fig. 7, diagram (c) represents the moment of weight curve corresponding to the statical weight curve in diagram (b). Since

$$\frac{d^2\theta}{dt^2}$$

is the same along the length of the ship, and g is a constant, any ordinate of diagram (c) represents

$$\frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2},$$

and so diagram (c) may be taken to represent the "virtual" alteration in weight due to the rotational acceleration. It is necessary, accordingly, to adjust the vertical scale of diagram (c) so that the moment of transference given by it shall equal the moment of transference of buoyancy

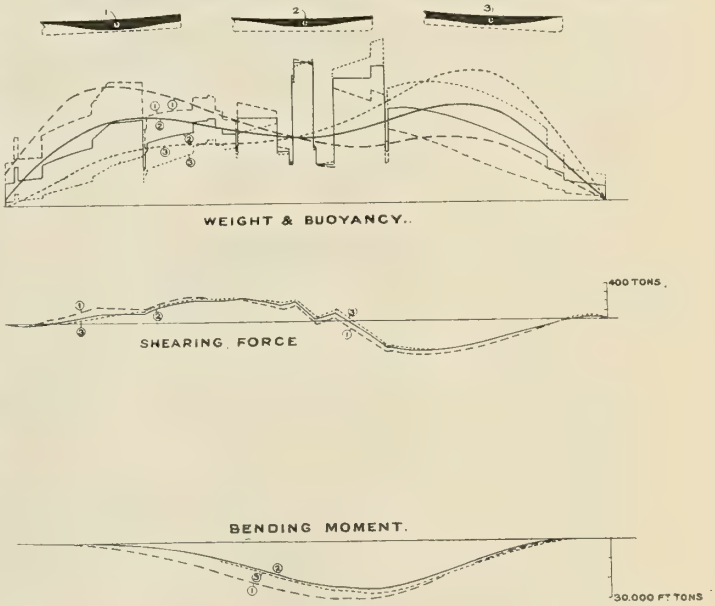


Fig. 9

found from diagrams (a) and (b). By means of an integrator set with the axis perpendicular to the base line, the areas and centers of areas of the positive and negative portions of the diagram are determined. Since the total moment of weight about center of gravity is zero, the areas of the two portions are equal and are represented by b_1, say. Let the distance apart of the centers of area be d_1. Then, "virtual" moment of transference of weight $= b_1 \times d_1$, and this must be equal to the moment of transference of buoyancy ($\delta \times d$), or m. So long as the length of base of the moment of weight diagram is unchanged, the centers of area are in the same longitudinal position, and are not affected by any change in vertical scale. Accordingly, any desired moment of transference can be obtained by altering the vertical scale of the moment of weight curve. For example, let the area representing b_1 in diagram (c) be A_1; and suppose it is found that ($A \times d_1$) represents ($\delta \times d$). Evidently it is necessary to alter the area of diagram (c) until it is the desired quantity A; this is done by altering every ordinate in the proportion

$$\frac{A}{A_1}.$$

Instead of plotting a new moment of weight curve whose area will be the desired amount, the amended ordinates are used for the correction of the statical weight curve. In this way the "pitched" weight curve in diagram (*b*) of Fig. 7 was obtained. This "pitched" weight curve has each ordinate amended by a quantity representing

$$\frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2},$$

moment curves can be obtained by integration in the ordinary manner. Such curves are curves *including* the effect of pitching. Examples are given in Figs. 8 and 9, the amount in each case being 4 degrees. The corresponding statical curves are also given, marked "2" in each case.

The investigation of the effect of pitching was carried a stage farther by varying the distribution of the cargo carried in the two "standard" conditions. The total amount of cargo carried was kept constant, as was the position of the center of gravity; but the cargo was concentrated in Nos. 1 and 4 holds, and in Nos. 2 and 3

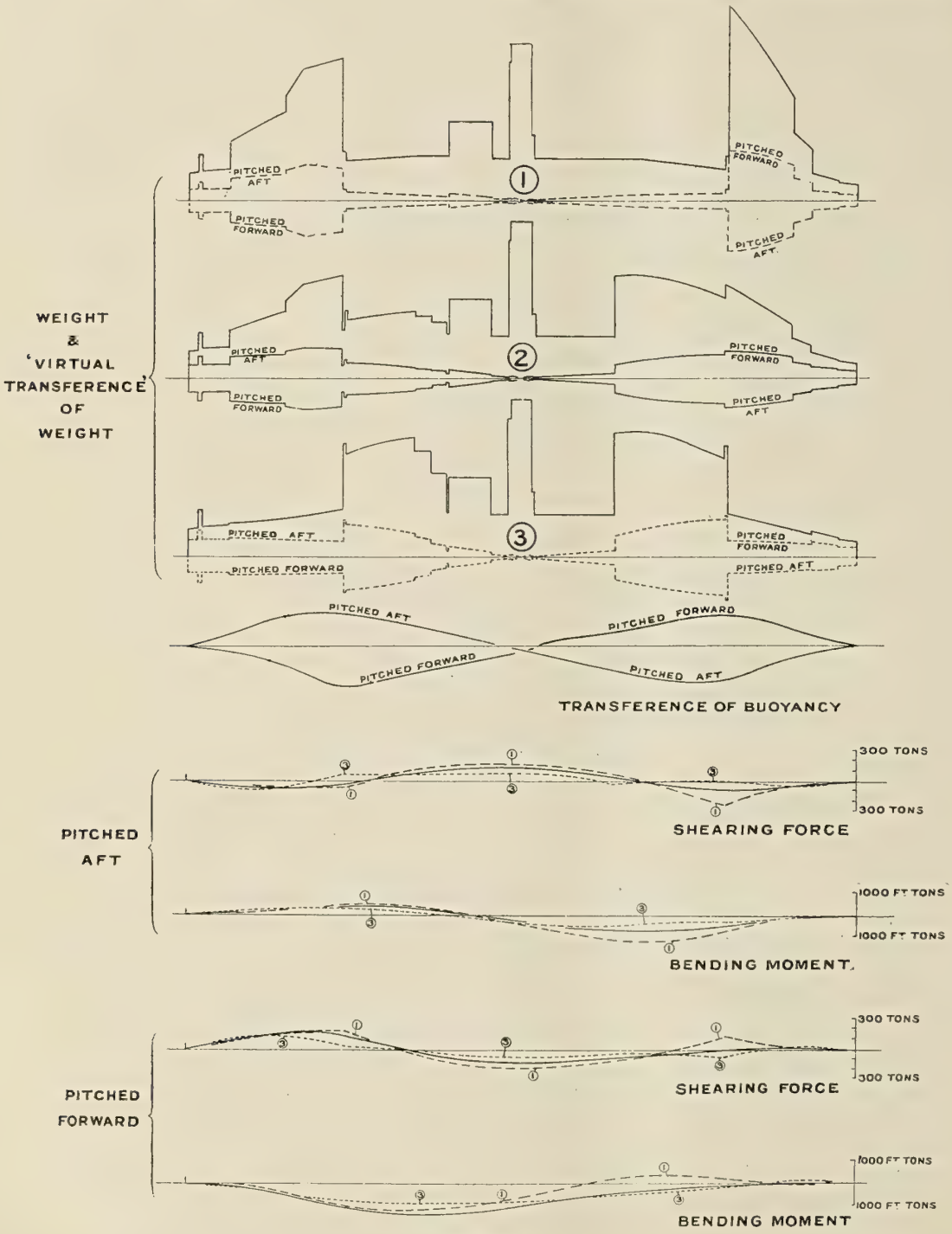


Fig. 10

the extent of the amendment being such that the "virtual" center of gravity is in the same vertical line as the "pitched" center of buoyancy.

From "pitched" weight and buoyancy curves obtained in the manner outlined above, shearing force and bending holds. Thus the weight curves shown in Figs. 10 and 11 were obtained. In each case the weight curve marked "1" is that which will produce the maximum statical bending moment; the curve marked "2" is the "standard" loading.

Corresponding to these distributions of weight, curves

of "virtual transference" of weight were obtained in the manner outlined above; these are shown in conjunction with the weight curves. From these "virtual transference" curves in association with the curve of transference of buoyancy shearing force and bending moment curves *due* to pitching were obtained by integration in the usual manner; these curves are shown in Figs. 10 and 11. The "solid" curves correspond to the "standard" conditions

able, though not sufficient to bring the sagging moment to equality with the hogging moment (see Figs. 9 and 11).

Considering now the effect of distribution of cargo, Figs. 10 and 11 indicate that this has a considerable effect on the shearing force and bending moment *due* to pitching. But it must be borne in mind that the statical curves corresponding to the weight curves in Figs. 10 and 11 will be widely different, and it seems a reasonable inference that,

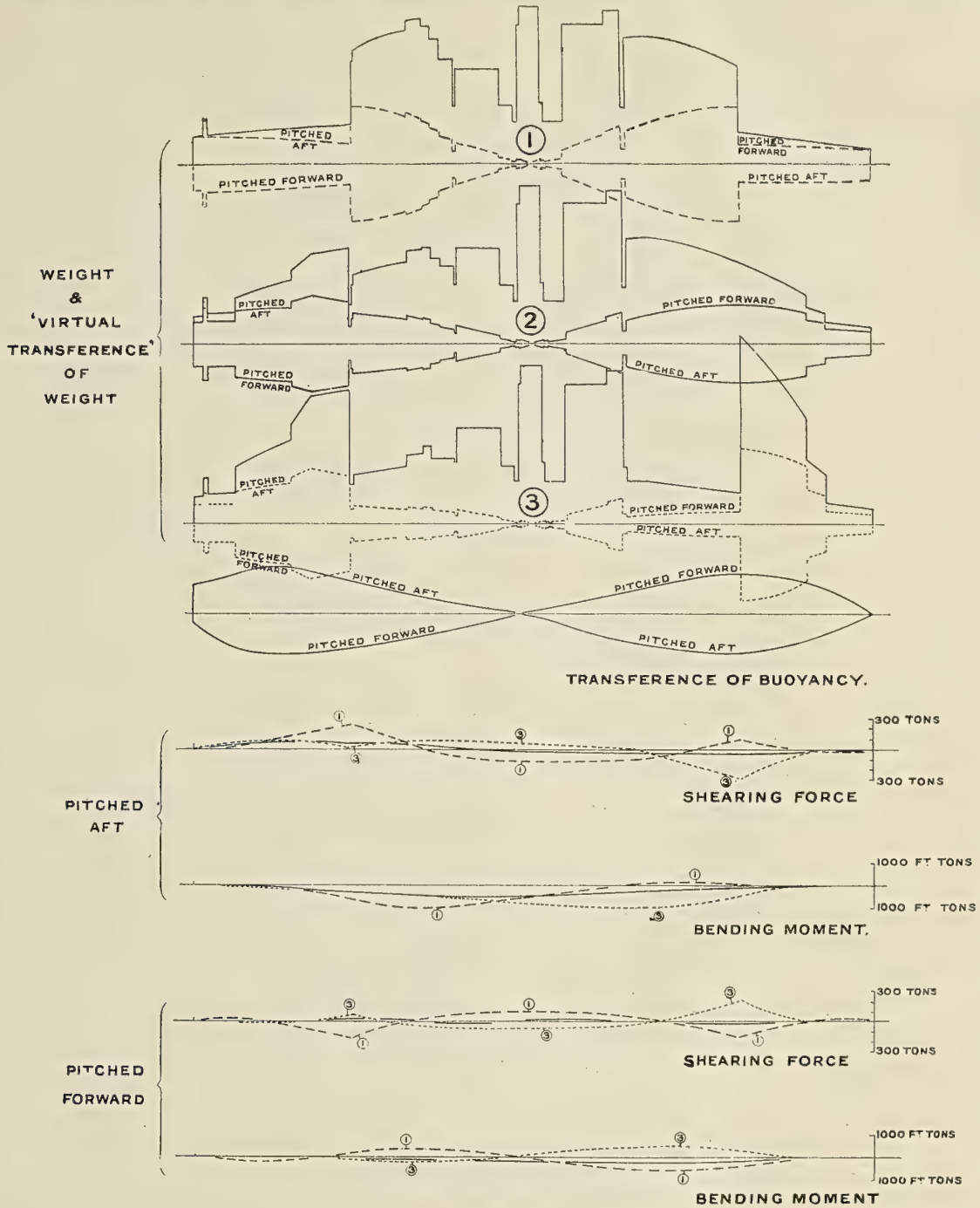


Fig. 11

of loading, and so are the intercepts between the "pitched" and statical curves of Figs. 8 and 9.

From Figs. 8 and 10 it is evident that, for the particular ship considered, the effect of pitching when in the hogging condition is not of great importance, causing, as it does in the worst cases, only a relatively small increase of bending moment over the ends of the vessel. On the other hand, for the same amount of pitch, when in the sagging condition the effect of pitching is quite considerrelatively to the corresponding statical curves, the curves marked "1" do not represent so great an effect as the curves marked "3." From this a possible inference is that the better the condition of loading as regards statical conditions the worse the condition as regards dynamic effects, and vice versa.

One object of the investigation outlined above was to obtain, if possible, a bending moment curve, or the "envelop" of a series of bending moment curves, which

would be almost flat in the region of the maximum value. This object has not been realized; even if the effect of pitching be included, the bending moment curve maintains approximately its maximum value over a very short range. Accordingly, the bending moments at the half lengths are always considerably less than the maximum values (see Figs. 1, 2, 8 and 9). The question then arises: Is it not possible, in many cases, to obtain sufficient longitudinal strength without maintaining the full midship scantlings over half the length?

A point of interest which arises from the pitching calculations is the effect of the pitching on local loads. For example, referring to the weight curve marked "1" in Fig. 11, it is seen that, due to pitching, the "virtual addition" to an element of weight in either end is practically equal to the normal weight; thus the weight of a windlass, say, may "virtually" be doubled as the result of pitching acceleration. Obviously the strength of the pillaring under the windless is not affected by the acceleration, and so in any case of stiffening under a local load the effect of pitching acceleration demands some attention, bearing in mind always that the effect is maximum at the ends, and minimum amidships. This consideration naturally leads up to the determination of the amplitude of pitching; it may be, for instance, that the combinations of pitching amplitudes and wave positions adopted above are highly improbable in practice. It is suggested that this matter can be investigated in an experimental tank. Waves of a desired period can be created; the ship model can be made dynamically accurate.

Taking Records of the Motion

From this point there remains only the observation of the motion. This might be carried out by means of the vertical cylinders used for measuring change of trim, an observer noting times at which wave crests passed the stern. Alternatively, a cinematographic record might be made, the positions of the ship on the wave being given by a series of draft marks along the side. In this way maximum amounts of "heave" and of "pitch," separately and in combination, might be determined. Then, for example, it might be found that a particular combination of heaving and pitching would possibly produce an excessive bending moment. The corresponding buoyancy curve would be drawn and its area determined. The weight curve would be proportioned up to the area so found; this would take account of heaving. By means of the moment of weight curve the "virtual center of gravity" would be placed in the correct position. Then from the amended weight curve and the buoyancy curve the shearing force and bending moment curves, including *both* heaving and pitching, would be obtained.

It might even be possible to carry the investigation of the motion of the model a stage farther and measure by means of special spring balances the variations of "virtual" weight along the length and so obtain curves of "virtual" weight for the model. These curves of "virtual" weight might be checked with the corresponding buoyancy curves, and so the application of the "Smith" correction tested.

In conclusion, I desire to acknowledge the great benefit derived from T. C. Read's paper, "On the Variation of the Stresses on Vessels at Sea Due to Wave Motion." Transactions Institution of Naval Architects, 1890, and from F. H. Alexander's paper, "The Influence of Longitudinal Distribution of Weight Upon the Bending Moments of Ships Among Waves," Transactions Institution of Naval Architects, 1911.

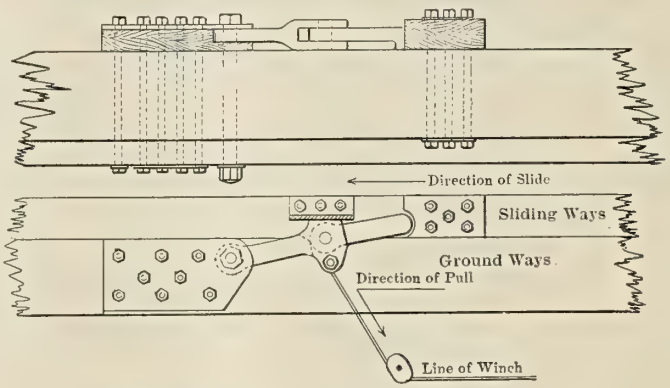
It is hoped that this treatise will prove of use to all naval architects who are interested in carrying forward these investigations.

Trigger Apparatus as Safety Factor at Launchings

The means and methods of launching or starting a vessel down the ways at the exact time and entirely at the will of the sponsor may be a puzzle even to men who have spent months around a shipyard. It is doubtful if one man in ten has a correct idea of just how to start a launching.

The release of the cradle or sliding ways so that they can start and slide freely down the greased ground or standing ways, carrying the enormous weight of the ship's hull safely into the water, has been accomplished by using several devices, one or two of them very old. One of the latest devices is described by Frank Gollan, superintendent of the G. M. Standifer Construction Corporation's wooden yards, Vancouver, Wash., as follows:

Under the bottom of the hull to be launched are placed two parallel fore and aft timbers, called the cradle, sliding or traveling ways. These timbers are carefully shaped and fitted to the outside contour of the ship's bottom at the location where the cradle carries the weight of the ship. The under side of these cradle timbers rests on the greased



Trigger Apparatus as Safety Factor at Launchings

surface of corresponding fore and aft timbers blocked up from the permanent timber structure of the shipbuilding ways, which are called standing, inboard, or ground ways. These timbers are laid straight with the outboard or stern ends which are nearest the water and lower than the ends at the bow, thus giving a slight inclination of the top surface towards the water, just enough to start the ship without force when it is released from its permanent attachment to the shore. One of the latest devices, illustrated herewith, is called a "trigger." This device is the last link between the ship's stay on land and her start towards the water. It is by this device that she is cut loose and the first step in launching is accomplished.

The ship is first wedged up. Then the big bilge shores are knocked out from under the vessel. Men then go under the ship between the ways and, starting aft, work forward toward the bow, splitting out the keel blocks. After this has been completed the great weight of the ship rests on the cradle and launching ways.

The trigger keeps the sliding ways or cradle from sliding down the ground ways into the water. This is a knuckle device, so designed that the greater the strain on the trigger, the more securely will it hold the ship in position. Since there are two tracks to the ground ways, it is necessary to have two triggers, one on each side of the keel, attached to the cradle and the ground ways. In order that they shall operate together, a cable is attached to each trigger. These two cables are brought together into a "bridle," to which a cable is attached leading directly to the drum of a winch, which, at a signal, the operator starts.

Control of Hull Construction of a 5,000-Ton Deadweight Fabricated Steel Vessel

Adopting a Drawing Room Policy—Development of Schedule to Control Production—Classification of Work and Relative Values

BY FABRICATOR

To secure satisfactory results from the drawing room, a policy must be followed which will not tie up the shop, will give constant employment to the regular drawing room staff and will eliminate, in so far as is possible, overtime and "extra men." This can best be accomplished by a careful analysis and classification of the work to be done and by working to a predetermined schedule based on an estimate of the work and using such standards as are available. The time is nearly always definitely known.

As the preliminary plans, diagrams and various calculations cannot be arbitrarily controlled with satisfaction, the naval architect should be instructed to prepare immediately all of the necessary erection diagrams covering the shell, vertical and side keelson, floors, tank top, bulkheads and decks, together with the preliminary framing, pillar and girder plan. The production of the mold loft offsets, launching diagrams and various ship calculations was left to the judgment of the naval architect and was held for the attention of his regular staff of ship's draftsmen.

Plans to cover the work to be done at the yard were prepared by the regular staff according to shipyard practice, but in conjunction with the fabricating plans. Most of the detailing was left for the mold loftsman to develop. This scheme enabled us to build up an organization of structural steel draftsmen to turn out the plans required for the work to be done by the fabricating shops. A schedule was developed to control the production of these plans.

The contract classification of the work and the price paid the fabricator for the different classes of work were used as a basis for assigning relative values to the classes which were to be covered by the drawings or plans to be made. These plans were classified in accordance with the fabricator's schedule. In the case under consideration, the classification of work and relative values assigned were as follows:

Class	Description	Relative Value	Weight
A	Punching flat rectangular plates	.279	520
B	Punching flat sketch plates	.126	203
C	Punching straight shapes	.003	20
D	Complete open and solid midship floor—includes intercostals	.110	85
E	Complete open and solid forward and aft floors—includes intercostals	.132	90
F	Complete center vertical keelson	.023	22
G	Complete pillars	.006	10
H	Hatch coamings, complete	.016	20
I	Frames, complete	.061	95
J	Deck beams, girders, bulkhead stiffeners, angle columns and struts, complete	.100	155
K	Panting stringers, brackets and gusset plates, all foundations, breast hook and stays—fore and aft web frames	.069	50
L	Complete watertight and oiltight floors	.062	40
M	Shear strake doubling plates	.013	20

It was necessary to complete all drawings at least four weeks before they were required by the fabricator. It was consequently decided that April 15 would be the completion date of all of the hull drawings, and that January 5 would be assumed as the date for starting, or an allowance of one hundred days to turn out the fabricated drawings complete. A complete analysis of the drawings was then made. It must be understood that all of the values in this analysis are arbitrary and that the schedule was adjusted many times before the drawings were complete. It served, however, the very good purpose of enabling the drawing room to anticipate delays which would have held up production at the fabricators, and the "value" assigned to the various classes of material was proven fairly accurate. This "value" multiplied by the number of days allowed to complete the job will give the number of days in which that particular class should be completed. Where the class is split among two or more drawings, the time element is in direct proportion to the weight.

Referring to the analysis of drawings, the first line covers the flat plate keel, which lies wholly in class A. The fabricator should produce seven plates with the necessary butt straps for each ship. It should be possible to cover these seven plates with two drawings; the plates and straps will weigh approximately 20 tons. Referring to the classification schedule, we find that the 520 tons of this class A, to be produced, should be turned out by the drawing room in approximately (.279 × 100 days) 28 days; 20 tons is .038 of 520 tons. Accordingly, this lot should be drawn up complete in .038 of 28 days, or 1 day. As there will be two drawings, two draftsmen, or the equivalent of two draftsmen, will be required with a checker, and this will require three man days. This process is followed for each class, and, as a safety check, the final completion date for each group of drawings or plans is put in five days ahead of the date of delivery to the fabricator. A record was made of the date each group was started, but this was not continued, as the chief draftsman's plan-record carried this information in detail for each drawing. Summing up the analysis of drawings, we find that we will have to make approximately 97 drawing to cover the work to be done by the fabricator. This will require 900 man days, or a daily average of nine draftsmen, employed only on plans to go to the fabricator.

The following of this plan was not all smooth sailing. These estimates, however, gave us a tangible beginning and end, and enabled us to so classify our drawing room force that the permanent organization was not only not disturbed but was kept on work with which it was thoroughly familiar, and a new organization, of a temporary nature, was built up of "bridge builders" and "structural men" who were not trying to qualify as ship draftsmen. Incidentally, "overtime" was under absolute control.

The machinery draftsmen carried their work parallel with the hull draftsmen. But as their plans and layouts were required at times which were controlled by the handling equipment of the yard and method of erection, no effort was made to control their output except to secure completion of their plans prior to the date of starting installation of the equipment which they covered. Drafts-

ANALYSIS OF PLANS FOR FABRICATOR

	Class	No. Item	Drawing	Weight Tons	Estimated Days	No. Men	No. Checkers	Man Days	Must Start	Must Complete	Started
Keel, flat plate	A	7	2	20	1	2	1	3	2/8	2/20	1/5
Keel, vertical	F	8	6	22	3	6	2	24			
Bot. shell plating	A	50	7	87	5	7	2	45	3/10	3/25	
Floors	D	45	5	85	11	5	1	66			
	E	67	5	90	13	5	2	91	3/3	3/30	
	L	17	9	40	6	9	2	66			
Tank top	A	67	5	115							
	B	22		28	9	5	1	54	3/20	3/9	
	C	16	3	6	7	3	1	4			
	K	..	5	16	2	5	2	14			
Bulkheads	A	35	1	55							
	B	15	8	25	10	9	2	110	2/8	3/15	
	C	26		10							
	J	80		25							
Frames	G	9	1	10	3	1	..	3			
	I	50	3	86	6	3	1	24	2/25	3/19	
	K	4	2	6	2	1	..	2			
Deck beams	J	136	7	90	7	7	2	63	3/3	3/23	
	K	...		17							
Shell plating	A	49	6	108	5	5	1	30	3/9	3/25	
	M	8	1	20	2	1	..	2			
Decks	A	85	7	90	..	7	2	..			
	B	53	..	60	8	..	..	72	3/10	4/1	
	H	5	2	20	2	2	..	4			
Houses	A	..	..	45							
	B	..	..	90							
	C	..	12	4	15	12	3	225	3/3	4/10	
	I	..	..	9							
	J	..	..	40							
	K	..	..	10							
Totals			97			95	25	902			

men in shipyard work design, as a rule, from a book of specifications, and delays due to changes in equipment frequently hold back delivery of necessary drawings to the shop and yard, drawings for which workmen are waiting.

A schedule covering machinery equipment and outfit will be covered in a future number of this publication.

Salvaging the Steamship St. Paul*

Methods Used in Turning Vessel—Character of Problems Solved—Placing a Patch Under Difficulties

BY CHARLES M. HORTON

TWENTY-TWO divers and over two hundred laboring men, not including the individual crews attached to the eight huge derricks which were brought into the work, were engaged on the job of salvaging the steamship *St. Paul*, a vessel 535 feet long, 63 feet beam, 26.8 feet depth, and with a gross tonnage of 11,629, which recently foundered in the Hudson River between docks 60 and 61, New York City. The Merritt & Chapman Derrick and Wrecking Company, 17 Battery Place, New York, had the work in charge. The boat lay about fifty feet distant from Pier 61, with the lower side of her submerged open decks in fifteen feet of mud—a mass of tangled and broken rigging. In turning over, she had struck her masts and funnels against the pier sheds, and when the salvors came her foremast lay broken off close to the sun deck. Interiorly, a notable feature was that the 85 percent magnesia used in boiler and pipe coverings had successfully withstood the protracted submersion in water and grime and slime in the vessel.

In putting through the work, various clever makeshifts were found expedient. Ventilators were used as connections with the lower decks, through which blower pipes were inserted and air blasts passed down to drive out the mud. A number of steam mains were laid along the upper side of the vessel and tapped off at convenient places to serve the steam pumps installed along the side. Electric wires were strung to light the operations of the workmen below. A barge moored alongside the ship served as machine shop and power plant. Its equipment included a portable boiler, a large air compressor, a small air compressor, a water tank, a drill press, a power saw, some pipe cutting tools, an emery wheel, a telephone, a forge and all necessary hand tools.

The work of salvaging resolved itself into three major operations. The first operation consisted of placing rigging and cables and pontoons with which to roll the vessel high and free of the mud. Speaking of mud, by the way, it is estimated that in the lower part of the vessel and along the alleyways on the port side of the decks the ship contained over two thousand tons of mud. Lodgments of mud in the vessel and quantities outside, which constantly gained entrance, proved the one stubborn obstacle against the work of salvaging. The mud between Pier 61 and the wreck alone was some fourteen feet high in places along the decks. Dredging was, accordingly, necessary between the ship and the pier before it was

* Illustrations by courtesy of Merritt & Chapman Derrick and Wrecking Company.

Fig. 1.—Showing "A" Frames and Pumps at Work in the First Rolling Effort

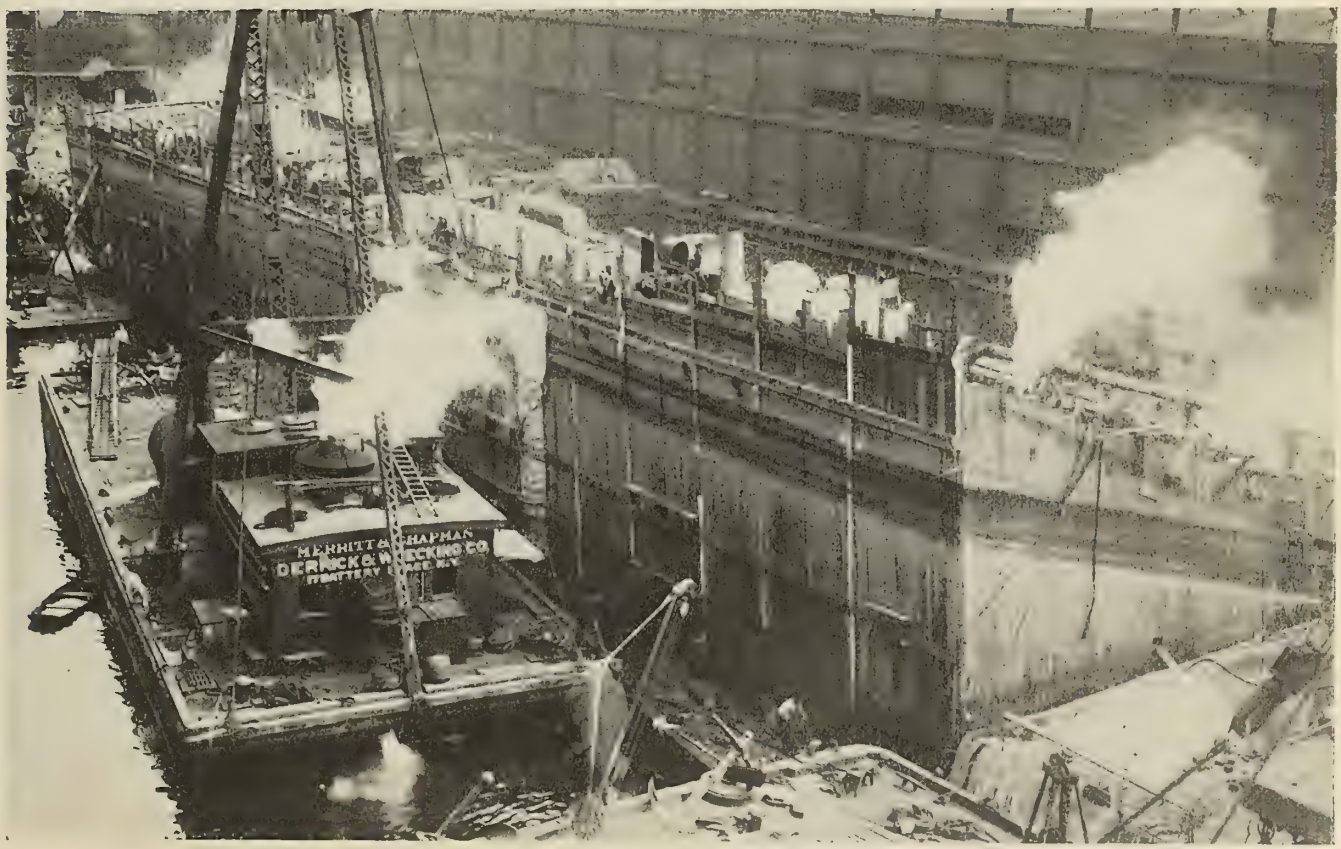


Fig. 2.—The Main Cofferdam Was 360 Feet Long on the Port Side and 290 Feet Long on the Starboard Side

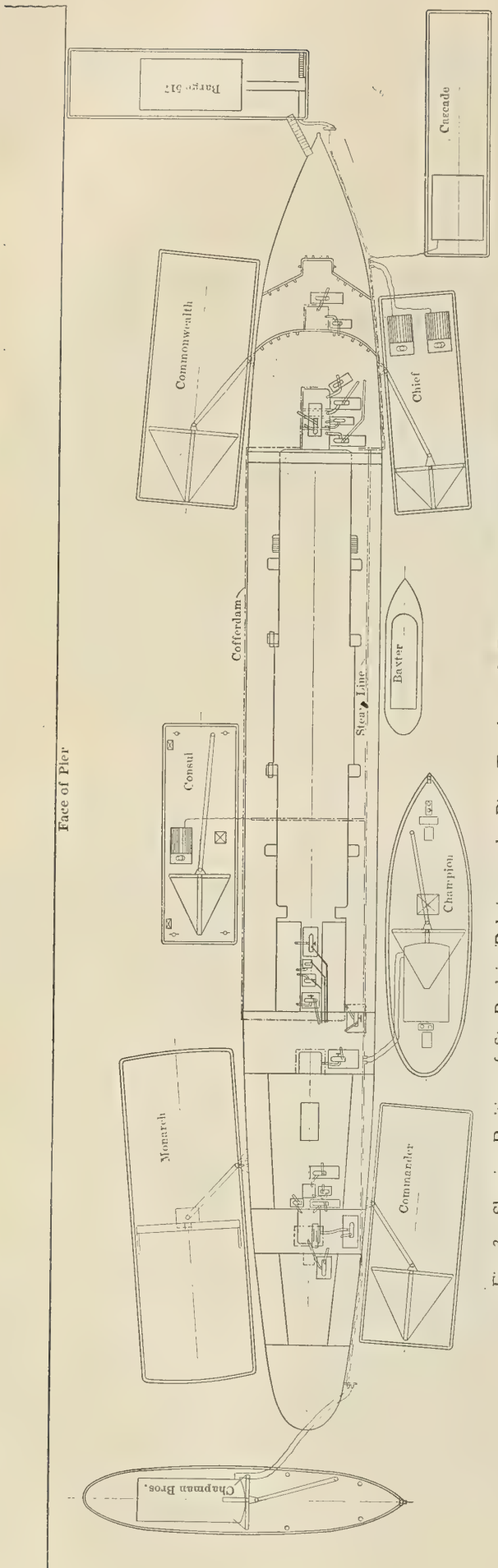


Fig. 3.—Showing Position of *St. Paul* in Relation to the Pier, Together with Position of Derricks in Relation to Vessel

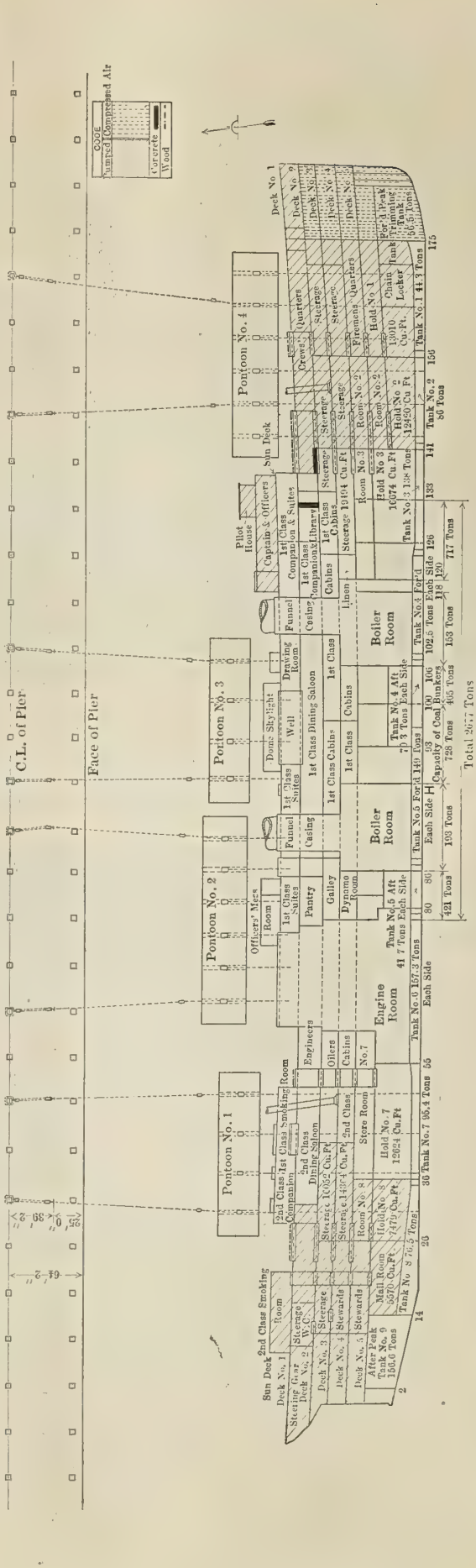


Fig. 4.—Diagram of Vessel as She Lay Before Arrival of Salvors, Showing Areas Which Were Pumped Out and Partitions of Wood and Concrete Which Were Used in Closing

Fig. 5.—View of the Vessel as She Looked the Second Day After Sinking

possible for the divers to make their way to the port side and along the keel in their work of establishing connections. Cables were strung from the vessel to a point eighty feet below water between Piers 59 and 60, where further dredging was done to accommodate twenty-one concrete anchors, each ten tons in weight.

The pontoons exerted approximately 1,200 tons lift. Also, twenty-one hoisting engines were installed along the edge of Pier 60, to pull on the tackles attached between the "A" frames made fast to the ship's side and concrete anchors in the next slip exerting an 840-ton pull. Checking wires were then led around and under the ship and made fast with tackles to Pier 61. This was done in order that the vessel be properly stayed against a possible sliding to the southward while being rolled. Another preparation was the installation of pumps along the forward and aft ends of the ship by which the mud and water were to be pumped out of the forward part of the ship, the pilot house, the captain's and officers' rooms, the after end of the ship and the smoking room aft, all of which had been made tight by divers. With these and other preparations completed, the work of actually lifting and rolling the vessel began.

The pumping and pulling continued for six days. The first day the ship was rolled to a point some thirty-six degrees toward an even keel, and thereafter a gain of a little less than two degrees each day was made, until, with the end of the sixth day, with the vessel lying some twenty-seven degrees from the perpendicular, the work of rolling was temporarily suspended and preparations undertaken for the second operation. This consisted of two steps—taking off the pontoons and closing the entire vessel. The former was accomplished without difficulty, but the latter compelled the use of some novel engineering measures in order effectively to guard against a return into the hold of mud and water.

This work, which meant the closing of the entire vessel, was done, of course, by divers. Scuppers, water-closet openings, garbage hoppers and chutes, bathtub openings, and the like, were sought out by these men and one after another effectively sealed. In more than one instance the divers had to grope and dig their way through mud inside the vessel in order to gain access to the portholes and close them. One very effective piece of work was accomplished when a diver placed a patch over an ash port fifty-three feet below waterline. The patch used was an iron plate twenty-one inches by twenty-four inches, oval in shape. In the work of placing this, sixteen bolts were screwed up with marked neatness. It was completed in less than two days. Another novel stunt was accomplished with concrete, where a slab over a foot thick was used to seal over two of the hatchways. With this done and all openings and ports, of which latter there were over a hundred, closed, the second stage of the work was commenced.

This was a continuation of the pumping and rolling operations, but with the additional advantage of derricks lifting on the chains previously attached to the pontoons. One derrick lifted on the chains attached to the forward pontoon and another lifted on the chains attached to the after pontoon. In this way the vessel was brought from twenty-seven degrees to sixteen degrees from the vertical. In this work also the pull on the "A" frames, exerted by means of cables attached to the hoisting engines on Pier 60, was continued, as was also the work of pumping out, both of the ship and the cofferdams built on the ship.

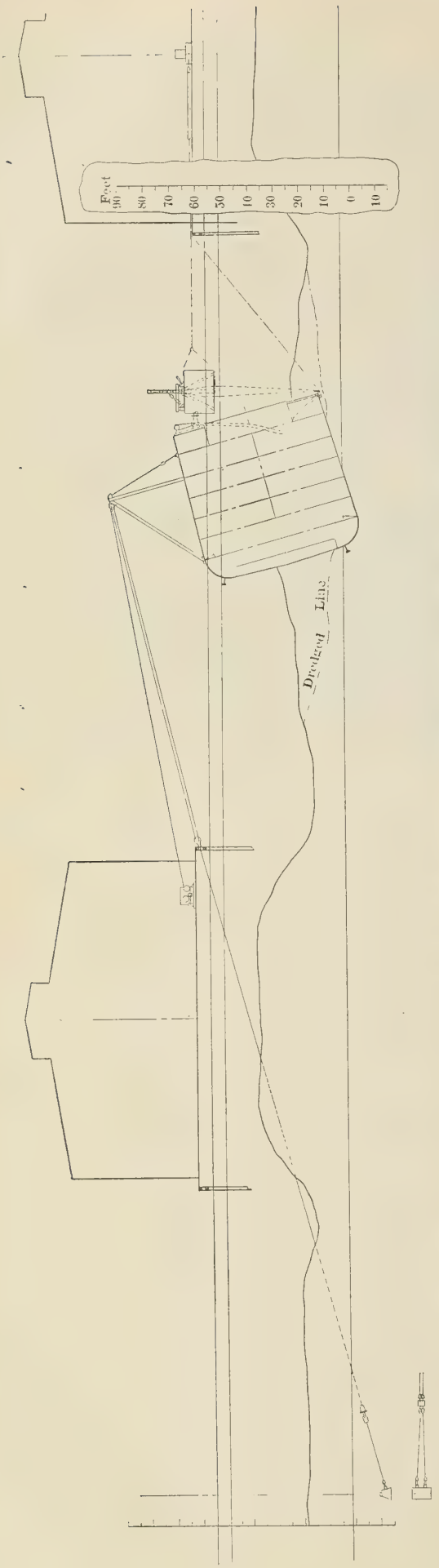


Fig. 6.—Diagram Showing Position of *St. Paul* and the Way in Which Anchors and Cables and Hoists Were Placed for Lifting and Turning the Vessel

There were a number of cofferdams used, one embracing hatch No. 1, and with one each around hatches Nos. 2 and 3. However, these last were connected with and made an integral part of the main cofferdam, which was 360 feet long on the port side and over 290 feet long on the starboard side, and which extended from a point forward of the bridge to a point about six feet aft of the after end of the engine room. Similarly, there were cofferdams about hatches Nos. 4, 5 and 6.

One of the difficulties met with in pumping the *St. Paul* was the drainage of the large number of compartments. Dynamite was used to break through some of the restraining walls, but the most satisfactory results were obtained by the use of an underwater cutting device invented by two members of the salvage force and here used for the first time. Twelve holes were cut by this method to allow the water within the ship to drain to the large pumps.

After bringing the vessel to a sixteen-degree list, preparations for entering upon the third, and last, stage were begun. The "A" frames were removed and ballast, which was brought on lighters to the extent of six hundred tons of rock, was placed aboard the vessel. Two hundred and fifty tons of this were set into hatch No. 4—through a chute and in such a position that the weight lay at a point amidships to a point as far outward along the starboard side as it proved possible to reach; another hundred tons were placed in hatch No. 2 in the same manner, and an additional two hundred and fifty tons were set into the forward starboard coal bunker, loaded through a coal chute which had been reinforced for this purpose. The job was now in shape for the third operation—the floating of the ship.

It consisted primarily in pumping out the entire vessel. In order to do this without danger, the ship had to be steadied also. The work of steadying was done with the aid of four large derricks, two on the starboard side and two on the port side. Five hours from the moment when the pumps were started the vessel righted herself to a position about four degrees from the vertical, and she was completely afloat, both forward and aft. The pumping operations were continued for a period of two weeks, although the ship continued with this four-degree list, owing to the fact that everything movable within had fallen over to the port side. Nevertheless, during this time she continued to float higher, because of the steady removal of weights and sections of cofferdam by the workmen, as well as the continued flow of water and mud which was being lifted out of her port side. The workmen followed the work down as rapidly as the changing conditions would permit, cleaning out deck two, and then three, and then four, until it was seen that under the circumstances the vessel would heel permanently to port. To overcome this, some three hundred and five tons of ballast, in addition to the amount already placed there, were put into hatches Nos. 1 and 2, which brought the ship to an even keel.

Altogether, the work of salvaging was very commendably brought about. Much care and foresight was needed in order successfully to prepare for the work, to say nothing of the engineering skill which was needed to bring the vessel to an even keel. Not the least of this was the cement patches over the hatchways, which are indicated in the illustration, and which, while known to have been placed under almost insurmountable obstacles, yet bore evidence, after the vessel was raised, of having been a most complete and correct job of closing. The credit for this and other details, as well as the work of salvaging the vessel as a whole, goes to Captain I. M. Tooker, who superintended the job, with Mr. Ralph E. Chapman acting in the capacity of salvage engineer.

Conservation and Stabilization of Man Power in Shipyard*

An appeal to all shipyards to conserve and stabilize their labor to meet the growing labor scarcity has been issued by the United States Shipping Board Emergency Fleet Corporation. To handle the situation caused by the calling of men into military service, it has been recommended that each shipyard work toward the establishment of centralized employment departments.

The necessity of conserving man power is obvious. An inventory of the working forces in the shipyards will reveal that, while the scarcity of men may seriously aggravate the industrial situation, in many cases it is by no means the greatest handicap to production. The handicap frequently lies in handling the problems related to obtaining, choosing and retaining employees without careful plan or thought. To overcome this situation and thereby often solve the shipyard's production difficulties, the shipyard should have definite means of knowing how to find competent men, either outside or within the yard; it should hire men carefully, with due regard for their qualifications and ability, and assign them to tasks which are within their capacity and to which they are well suited, and it should surround them with such good facilities for living and such incentive to effort that once placed on a job they cannot be readily induced to leave. That is stabilization.

Functions of Employment Department

Realizing the necessity not only of having enough labor available, but of stabilizing it, the president recently issued a statement centralizing all activities for recruiting unskilled labor for war industries in the United States Employment Service. In this way the President has called the nation to the aid of industry, and industry must respond in the same spirit as the nation offers its aid. Not only to increase production by stabilizing labor, but to afford the government proper assistance in this programme, each yard should establish a single centralized channel through which all workers are secured and with which the shipyard officials, on the one hand, and the government recruiting officers on the other, can deal.

The functions of a properly constituted employment department may be broadly and briefly defined as follows: *To develop sources of labor supply that will provide a sufficient number of competent employees; to select and place employees in the jobs to which they are best fitted; to control questions of transfer, promotion, discharge, and other adjustments affecting the employee relationships in the plant, and to develop within the organization plans for mutual helpfulness that will promote a spirit of genuine co-operation and understanding between the management and the employees.*

Qualifications of the Employment Manager

An employment manager should be a capable, executive, broad-minded, fair and square, and of sympathetic temperament, in order that he may be easily approached by any man in the organization. He should be ready at all times to listen to their complaints, troubles or suggestions, and big enough to solve their problems and keep them happy and satisfied with their work. A man in this position needs to possess courtesy, even temper, patience, and ability to be a good mixer. Furthermore, he should have sufficient poise and dignity to sit at a council table with other executives and heads of departments and discuss current plant problems intelligently.

The employment management branch of the industrial service section is training men as employment managers for the shipyards. Besides the preliminary training at various universities, these men receive the benefit of actual shipyard experience under the direction of the Emergency Fleet Corporation. Plants interested in securing an employment manager may communicate directly with the industrial service section of the Emergency Fleet Corporation. When the employment manager is chosen, his policy and plan must be properly introduced and explained to the foreman and superintendents, and his relation to the entire shipyard organization be clearly established. It is essential that the necessity for the new department be demonstrated. This matter can be effectively handled by showing the effect of labor turnover—what it means to the company to hire and break in a worker under the old scheme, with the lessened production, accidents, cost of instruction, spoiled work and other factors involved, and what an expensive mistake it is to lose this man just as he becomes a real producer. The cost to the individual workers who lose time and money in passing from job to job and in moving their homes from place to place may also be cited. This shifting about leads to industrial unrest and decreased production. Out of this situation the need has clearly arisen for some department to devote its exclusive attention to finding means for improving these conditions. The employment manager is trained to cope with the situation; the centralized employment departments supply the necessary organization.

Need for Technical Men

Together with this, though not directly in line with it, a strong appeal is made to the naval architects and marine engineers who are now engaged in non-essential work to take up positions in the shipyards. The number of naval architects, marine engineers, hull draftsmen, engine draftsmen and other high-grade, technically trained men wanted by the leading shipyards at the present time is approximately 325. At present, practically all marine engineers and naval architects are engaged. The shipbuilders are therefore desirous of securing structural engineers, civil, mechanical or architectural engineers who could fit into this special field. Several of the yards are using such engineers on the construction of hulls or in the installation of machinery.

Offers Excellent Opportunities

This field of actual construction offers excellent opportunities for young technically trained men. Those qualified are urged to get in touch with the situation through Supervisor Frank P. McKibben, United States Shipping Board, Emergency Fleet Corporation, Philadelphia.

As a further effort to meet the situation, a series of intensive training courses (each of ten weeks' duration) in naval architecture and shipbuilding are being organized under the Emergency Fleet Corporation at the Massachusetts Institute of Technology, Cambridge, Mass. The first section matriculated September 30, 1918.

Requirements for Enrollment

Applicants for enrollment in this school should be graduates of civil, mechanical, electrical, mining or architectural engineering courses, if not graduates, or should have the equivalent of such training. Men who have completed their junior year in college in any engineering course mentioned will be accepted if the school is not previously filled with graduates or the equivalent. Applications should be sent to the Education and Training Section, Emergency Fleet Corporation, Philadelphia, Pa. Those men especially qualified for the work should get into the game at once.

* From the handbook on employment management prepared by the Industrial Relations Group of the United States Shipping Board.

Analysis of Gas and Gasoline High-Speed Engine Design*—I

Comparisons and Analysis of the Two Fuels—Diesel Engine—How to Hold Detonations in Check

BY HARRY R. RICARDO, B. A.

THE author proposes to examine and set out some of the features of high-speed engine design, and to indicate some of the points upon which the designers of these engines have concentrated their attention. In the first place, most of these smaller high-speed engines are designed to run on gasoline (petrol), and it is sometimes argued that the conditions under which they operate are totally different from those that apply to the larger and heavier types of internal combustion engines. This is true, but to a limited extent only, for, generally speaking, what applies to a gasoline (petrol) engine will, with certain reservations, apply equally to a gas or Diesel engine, while, so far as mechanical conditions are concerned, the problems to be faced are practically identical in either case.

During the course of the war the development of light high-speed engines has progressed with remarkable rapidity and has received a very great impetus from the fact that a large number of well-trained and scientific men have devoted their attention to it, and, taking advantage of the many excellent mechanical features already to be found in these designs, have also directed their development along sound scientific lines.

Advantages and Disadvantages of Gas and Gasoline

In answer to any imputation as to their lack of theoretical knowledge, the designers of high-speed gasoline (petrol) engines almost invariably used to reply with the retort that, besides being able to run at much higher piston speeds, their engines could use higher mean pressures, and showed a thermal efficiency equal to and, in some cases, relatively higher than the average gas engine. This retort was generally true, and the author proposes, before proceeding further, to devote a short time to comparing the advantages and disadvantages of, say, gas and gasoline (petrol) as a fuel.

In the first instance, other things being equal, the power output of any internal combustion engine depends upon the weight of oxygen that can be taken into the cylinder and burnt in unit time. Here gasoline (petrol) scores a very decided advantage for three reasons:

1. In order to consume the whole of the oxygen present in the cylinder, the volume of gasoline (petrol) vapor required is only slightly over 2 percent, while that of gas is nearly 20 percent, consequently the volume of oxygen dealt with in the case of gasoline is 18 percent greater.

2. Owing to the latent heat of evaporation of gasoline (petrol) the temperature of the working fluid is reduced both before and during its entry to the cylinder. Hence a slightly greater weight is taken in for a given volume.

3. After combustion the specific volume of the working fluid consisting of an air-gasoline (petrol) mixture is increased by about 4 to 5 percent, while that of an air-gas mixture is reduced by about 3 percent.

On these three grounds alone gasoline (petrol) scores heavily, for not only does the fuel itself displace less oxygen, but it also withdraws heat from the charge, and thereby increases its weight, while finally the actual volume of the charge after combustion is greater than before.

On the other hand, gasoline (petrol) labors under two serious disadvantages:

1. Owing to its very limited range of inflammability, it is not possible, as with gas, to work with a weak mixture. In fact, the mixture giving complete combustion is almost identical with that giving maximum economy, for if the mixture be weakened to any appreciable extent below that required to give complete combustion, inflammation is seriously delayed and continues throughout the expansion stroke. As a result of this peculiarity, it is not possible by ordinary means to reduce the flame temperature, and, since the efficiency of any engine, relative to the air cycle efficiency, is dependent upon flame temperature (owing both to direct loss of heat and to the change in specific heat at high temperature), it follows that from this point of view a gasoline (petrol) engine can only operate under the most disadvantageous conditions.

2. Owing to its low ignition temperature and to the high proportion of hydrogen present in the fuel, it is not possible to work with so high a compression pressure. In practice the limiting compression ratio that can be used for gasoline (petrol) is about 5:1 (depending, of course, upon a number of subsidiary conditions). This gives an air cycle efficiency of 47.5 percent with gas; on the other hand, it is possible to use a compression ratio as high as 6.25:1, giving an air cycle efficiency of 52 percent.

Advantages of the Diesel Engine

We will consider next the case of the Diesel engine. This engine has the following advantages in its favor: (1) No fuel is taken into the cylinder until after the end of compression, hence no oxygen is displaced and the greatest possible volume is taken in. (2) The combustion of crude oil and air also results in an increase in the specific volume as in the case of gasoline (petrol). (3) Additional air compressed separately is nearly always admitted to the cylinder along with the fuel. The increase in mean pressure due to the presence of this additional air is invariably credited to the indicated power of the engine. This gives the Diesel engine an apparent indicated power which is altogether illusive. In common justice, the indicated horsepower absorbed by the compressor should be deducted from that developed in the cylinder, before any comparison is made between it and other internal combustion engines.

There are so many variables connected with the Diesel cycle that the author has not attempted to show a comparative mean pressure and efficiency curve. In the first place the air cycle efficiency itself varies with the flame temperature. Again, the proportion of air admitted along with the fuel has a powerful influence both on the mean pressure and efficiency, and that proportion is a variable quantity. Thirdly, the highest mean pressure attainable is governed not so much by consideration as to the quan-

* Extract of paper read before the Northeast Coast Institution of Engineers and Shipbuilders.

tity of oxygen present in the cylinder, but rather by the quantity that can be brought in contact with the particles of fuel and burnt in the short time available.

From the above figures it is clear that, while with gasoline (petrol) it is possible to obtain an indicated mean pressure of 146 pounds per square inch under extreme conditions, or 136 pounds per square inch under economical conditions, with gas it is not possible to obtain a higher mean pressure than about 110 pounds per square inch, even when working with the richest possible mixture. On the other hand, with gasoline (petrol) it is not possible under any normal circumstances to obtain an indicated thermal efficiency of more than 33 percent. With gas it is possible to obtain as high an efficiency as 37.5 percent when working with a weak mixture and a low-flame temperature. The best modern gasoline (petrol) engines, such as those employed for aircraft work, do actually realize an indicated thermal efficiency of over 32 percent, while gas engines have occasionally shown as high an efficiency as 37 percent, showing that in both cases there is not much scope for improvement so long as the usual cycle is adhered to. It is obvious, however, that the thermal efficiency of either type of engine, and more particularly of the gasoline (petrol) engine, could be greatly increased by working with a lower flame temperature; theoretically, the efficiency rises as the flame temperature is reduced, until at the point of no heat supply the efficiency will be equal to the air cycle, but the power will be nil.

Analogy of the Paper Bag

While the author has stated that, owing to the very limited range of inflammability of gasoline (petrol) and air mixtures, it is not possible by ordinary means to work with a weak mixture, and hence at a lower flame temperature; this, of course, applies only so long as the working fluid is homogeneous. It is interesting to consider what would happen if into a cylinder full of air there were inserted a paper bag containing a small charge of air-gasoline (petrol) mixture of normal density, and that at the end of compression stroke this mixture were ignited and the bag burst so that its contents, already fully aflame, were discharged into the large excess of air present. Under these circumstances the effect would be equivalent to working with an extremely weak mixture: the mean flame temperature would be very low and the efficiency very high. Some such condition as this can be reproduced in a practical form by means of stratification, and the indicator diagram, taken by means of an optical indicator from one of the author's high-speed experimental engines, shows the results obtained. When running under these conditions, indicated thermal efficiency was no less than 38 percent, with a mean pressure of 23 pounds per square inch.

Losses Due to Vaporization

While comparing the two fuels, gas and gasoline (petrol), there are two other points which need consideration. Gasoline (petrol) is a liquid, and before it can be used in the engine it must be vaporized, or at least finely pulverized. This entails a certain loss, though a very small one, and it also imposes certain restrictions in the design, especially in the design of the pipework, which must be carried out in such a manner that the pulverized and partially vaporized particles of gasoline (petrol) are kept in rapid and, as far as possible, continuous motion, in order to prevent them from precipitating on the walls of the pipework. The other peculiarity of gasoline (petrol) is its readiness to detonate on account of its chemical instability and of the large proportion of hydrogen present. Such detonation is generally referred to as "pinking," and often, but quite erroneously, as pre-ignition. Pre-ignition means, of course, self-ignition of the fuel before the end of the compression stroke. Detonation, on the other hand, is merely extremely rapid burning, so rapid, indeed, as to cause local rises of pressure, which spring the walls of the cylinder and cause them to vibrate as though they had been struck by a hammer. What actually occurs appears to be this: A portion of the working fluid in the neighborhood of the sparking plugs is ignited and proceeds to burn in the usual manner, but so rapidly that it compresses before it the rest of the unburnt charge, until the heat of compression is such that the unburnt residue ignites spontaneously and suddenly throughout its whole bulk; in other words, flame propagation proceeds normally at first and then suddenly changes and becomes practically instantaneous. This tendency to detonate is very tiresome, and it, of course, increases as the compression ratio is increased and the temperature and pressure of the working fluid are raised by compression. It is, as might be expected, dependent to a considerable extent upon the shape of the combustion chamber and the position of the igniter, and it also depends upon the density of the fuel; the denser the gasoline (petrol), the greater the tendency to detonate, presumably because the heavier fractions are chemically less stable than the lighter ones. It becomes particularly troublesome when working with paraffin kerosene. Such detonation is checked as follows:

1. By reducing the temperature and pressure of compression by the admission of water or other such means.
2. By increasing the proportion of carbon in the fuel by mixing it with hydrocarbons of the aromatic series, such as solvent naptha, metaxylene, or benzol.
3. By introducing inert gases, and preferably by adding gases containing carbon such as carbon dioxide. In practice this can be accomplished by readmitting cooled exhaust gases, a method frequently adopted in the case of large gas engines using coke oven gas, in which the proportion of hydrogen is large, and the same trouble arises.

This tendency to detonate compels the use of a lower compression ratio than would otherwise be necessary and is a serious handicap to the gasoline (petrol) engine.

(To be continued)

American Harbor Facilities Now in the Lead

Only a few years ago it was customary to use pictures and drawings of foreign ports, terminals and terminal facilities to illustrate the most modern construction and equipment. The passing of the old régime was silently recorded by the illustrations used in the address of H. McL. Harding at the monthly meeting of the Society of Terminal Engineers, September 24, at the United Engineering Society's Building, New York.

In this address every description, photograph, design, plan and operating condition referred to American port installations and practices, since these may now be considered the most modern examples of permanent quay walls, fireproof and decay-resisting construction, and of up-to-date mechanical facilities. These illustrations clearly demonstrated that the American terminals were equal and even superior to the best in Europe. Among the mechanical appliances shown were the half-arch traveling gantry jib cranes for discharging and loading vessels, also the internal traveling loop cranes for assorting, distributing and high-tiering. The latter equipment eliminates congestion at the point of freight deposition.

America may now be said to lead the world in port and terminal facilities. It is no longer necessary to refer to the terminals of the Rhine or the Rhine waterways as examples for the United States to follow.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Salvaging Torpedoed Ships

Unusual feats of ship surgery are at present being carried out by the Admiralty Salvage Department of the United Kingdom, which has grown from a nucleus of private enterprise to a big organization capable of tackling any ship repair job. A concrete idea of the incalculable value of salvaging is best gained from a study of some of the interesting details of the work of this department.

One of the largest tank steamers had been mined. The cargo consisted largely of benzine. It immediately caught fire. A heavy explosion flooded the decks with burning oil. With the wind aft, the blaze at first kept forward. The magazine went up and there were several explosions of gas from the petrol. As the wind changed the after parts of the ship took fire. Most persons would consider the case hopeless. Not so. The vessel was scuttled by forty shots fired into her, thus extinguishing the fire. Divers then went down, plugged the shot holes and closed other apertures. On being pumped out the vessel floated and was forthwith taken to a repairing port.

Another salvage may be sighted to show the value of the submersible electric pump. A ship which carried a cargo (mostly foodstuffs) valued at over $14,250,000 (£3,000,000) was torpedoed. The torpedo made a hole in the ship's side about forty feet long by twenty-eight feet deep. She was taken in tow by rescue ships, but went down before she could be suitably beached. At low tide, for about two hours, the shelter deck—fifty-eight feet from the bottom of the ship—was just awash. No ordinary pumping power would have served the need. The new type of pump enabled stoke-hold, engine room and after-holds to be pumped out so that cargo could be discharged and the vessel brought up further on the beach. Here the lightening process was continued until the vessel was floated and taken into dock with practically all her cargo saved.

One salvage vessel has fallen a victim to submarine attack, but the department's percentage of loss, both of life and plant, has been very small. The number of ships of the mercantile marine actually salvaged by the department in the two years from 1915 to 1917 was, it seems, 260. All were vessels of pretty large tonnage. For the present year, the monthly totals of such vessels salvaged were: In January, 14; in February, 41; in March, 37; in April, 36, and in May, 19. Thus the department has saved 407 important vessels of the mercantile marine. The larger figures of the latter period were due not to increased enemy activity, but to improved salvage methods. The total does not include vessels restored outside of home waters. It is impossible, of course, to raise the *Lusitania* and other vessels sunk in deep water.

The department has been at work on many ships at one time. For torpedoed damage, a standardized patch has been used which, when projecting parts of injured plates have been cut away, can quickly be bolted on. It is interesting to note that, after being temporarily repaired following a torpedo attack, two vessels were torpedoed a second time abreast of the first injury. In each case the standardized patch held firmly against the shock and the vessel was saved.

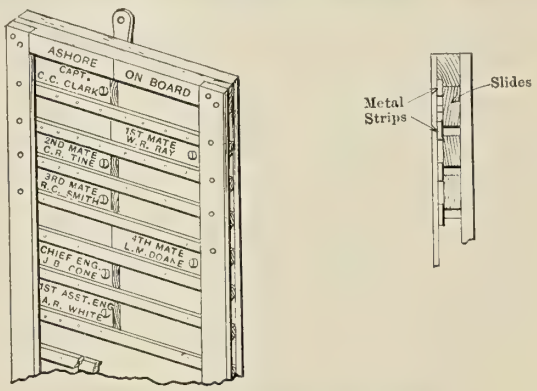
The salvage of a large government collier illustrates the recent advance made in salvage science. This ship, when partly laden, was sunk by collision in twelve fathoms of water, where she obstructed an important channel and anchorage. She weighed 3,500 tons. It had hitherto been believed that no vessel of more than 1,500 tons could be raised by wire ropes. After a great deal of sweeping work with salvage vessel, sixteen 9-inch wire ropes were placed in position under the bottom and brought up to four lifting craft placed over the wreck. Water was emptied from the ballast tanks and the vessel's weight thereby reduced to 2,750 tons. She was then lifted and carried a mile inshore clear of the anchorage. Following other lifts, this vessel was beached and patched, and, after being permanently repaired, she embarked on a new career of useful voyages.

Finally, a word should be said about the risks run by the divers, particularly those resulting from gases generated by decomposed vegetables and meat in the holds of the sunken vessels. Several deaths have resulted from this cause. Decomposing grain, it seems, produces sulphureted hydrogen, which occasions semi-blindness and violent sickness. An English chemist has found a preparation which, when sprayed on a rotting cargo, immediately kills the gases and thereby enables the men to carry on their work in safety.

Liverpool, England. MARK MEREDITH.

Handy Checking Board

This is not a new or original idea of the writer, but it is one that I have not seen passed on in the pages of MARINE ENGINEERING, so that a sketch of this board will be of interest to the readers. It consists of several sliding blocks or strips. On each block is painted in small letters

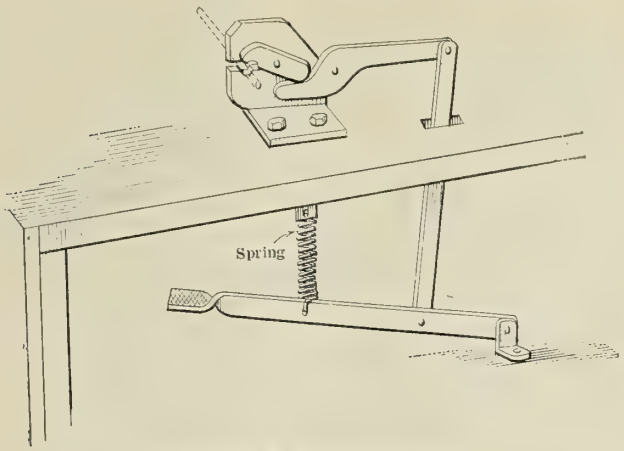


Handy Checking Board for Officers

the rank and name of each officer of the ship. These blocks are slid back and forth in grooves to show by their position whether the individual is ashore or on board, each officer checking himself on the board on leaving and returning to the ship. W.

Home Made Rod Shear

For making pins and shearing small drill rod, the boys made a small bench shear, a sketch of which is shown herewith. The frame was made from a piece of ½-inch

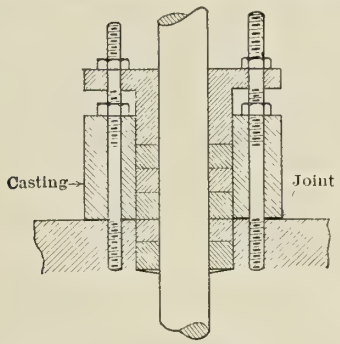


Drill Rod Shear Machine

boiler plate, as were also the levers and cutter. No dimensions are given, nor does a detailed description seem needed, as those to whom the idea might appeal will make it to suit their needs. ASSISTANT.

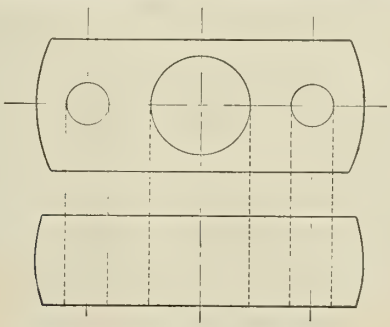
Glands

Sometimes the glands on pumps and engines are found, by experience, to be a little too shallow, with the result that oil, water, or steam, as the case may be, leaks out. With a gland holding only, say, two turns of packing,



Deep Gland to Stop Leaks

screwing the gland up tight to stop leaks will, in many cases, stop a pump, and on a fast running engine the rod will eventually get hot, with bad results.



Block Casting for Extending Stuffing Box

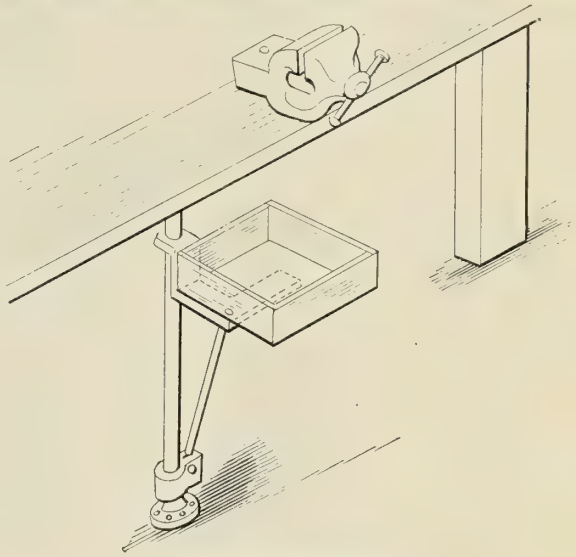
By deepening the gland and having five or six turns of soft packing in, instead of two, less pressure can be put on the gland nuts. In this way the leak may be stopped, and the thing will be a benefit in many ways. If there is enough clearance between the crosshead and the gland, a casting can be made two or three inches deep and jointed down by two long studs and nuts, as shown, so that the center hole in the casting is really an extended stuffing box, being the same diameter as the stuffing box. Longer studs will have to be fitted to make up for the extra depth of stuffing box.

Victoria, B. C. EDMUND B. DELL.

Quickly Accessible Drawer

This somewhat odd but very handy bench drawer has been installed under the writer's workbench. It is quite simple, as may be seen from the sketch, and can be made from odd stock found about the shop.

The upright or stanchion is made of pipe or could be



Swinging Bench Drawers

made of old boiler tube; the drawer bracket was made of ½ by 2-inch flat stock bend to the form indicated, the drawer itself being made of wood.

The real value of such a drawer lies in its quick accessibility and in the ease with which its contents can be seen at a glance. C. H. WILLEY.

Emergency Repairs to Main Check Valve Spindle

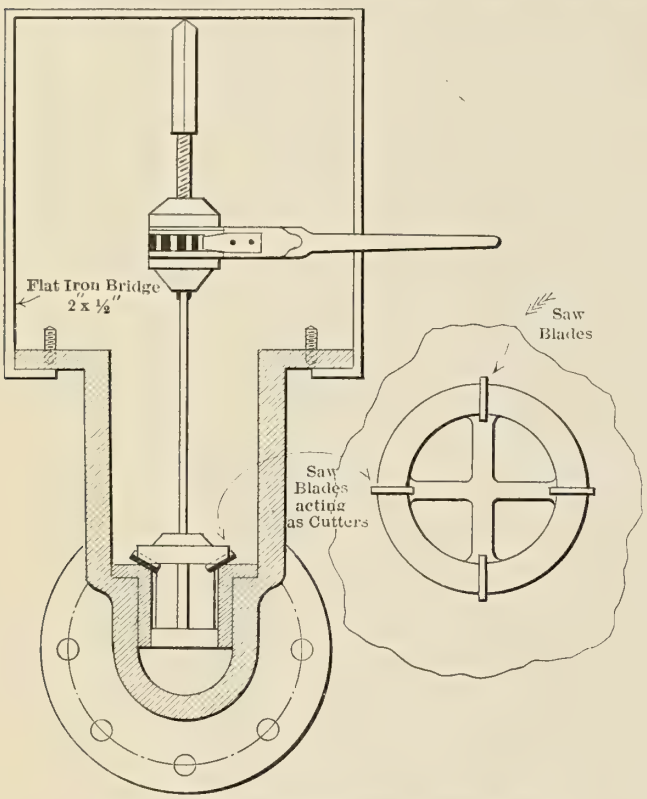
The following account of a breakdown at sea and novel method of repairing same may prove interesting reading and, perhaps, will be worthy of note by seagoing engineers, who very often have to make "something out of nothing," as one might say.

I was trading to the Far East from London. We received orders to go to Bangkok, Siam. When near our destination, one of the boiler main check valve spindles stripped, with the result that nearly all the feed water was going into that boiler. In order to prevent this we made a bridge, or bridle, out of a piece of flat iron about 2 inches by ⅜ inch and long enough to get a ratchet in below with a drill, to tighten down on the end of the spindle and so regulate the supply of water to the boiler. We had to anchor at a place fifty miles from Bangkok, as we were drawing too much water to make that port, and the cargo was shipped down to us in steam lighters.

On being informed that we would be three or four days loading, we decided to put in a new spindle, so the boiler was cut out and blown down below the check valve, and

afterwards released of the pressure altogether. The cover was then taken off and the new spindle fitted. The spigot, or stopper, on top of the valve, being broken through excessive hammering, was replaced with a new valve complete. On examining the seat, we found it so badly cut and full of holes that the next thing to do was to face the seat up, since even with a new valve and new spindle the valve would not be tight.

With no engineering shop within a radius of fifty miles, and no cutters or machine tools aboard to face the seat up, a good suggestion was made, which we acted upon and which proved to be a huge success. With the bridge, or bridle, we had made acting as a drill post, we fixed the ratchet underneath, and out of a flat drill we forged a screw driver and cut a slot in the top of the old valve to suit the driver. In the bevel or miter of this valve four



Emergency Tool for Grinding Valve Seats

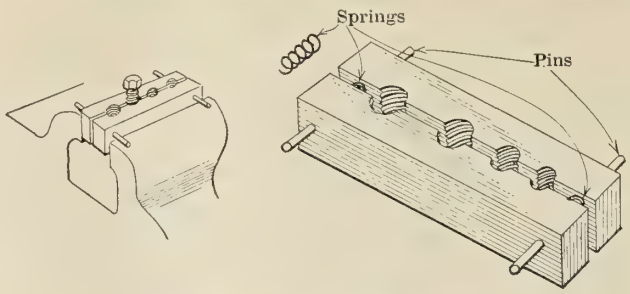
saw cuts were made almost the depth of a hacksaw blade. A hacksaw was then broken and four pieces were inserted in these slots, which were equidistant from each other, or 90 degrees on the circle. They protruded about 1/32 inch above the miter or bevel of the valve, and therefore the saw blades, being at the same angle as the miter of the valve, corresponded with the miter of the seat.

The valve was then placed in the seat, with the four pieces of saw blades acting as cutters. With the screw driver in the slot on top of the valve and inserted in the ratchet like a drill, and screwing up underneath the bridle by working the ratchet with a hand feed, we faced all the slots and holes out of the seat, and in the end the job was as good as if it had been done in the lathe.

Victoria, B. C. EDMUND B. DELL.

Two Shop Kinks

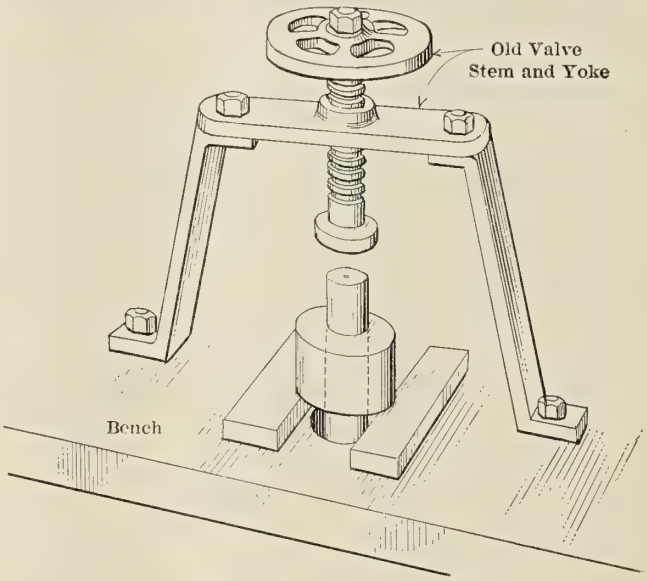
Here are a couple of kinks which the fellows working in the ship's machine shop will find worth adding to their collection. The jaws shown in illustration take studs, screws and bolts in the vise when threading, drilling or slotting. To make these, take a piece of stock, either brass or soft steel, 1½ by 1½ inches. Drill and tap a series of standard holes ⅜ to 1 inch; then drill two small



Special Clamp for Holding Screws

holes for the pins through each end on the sides. By splitting this piece through the center of the holes, two jaws are formed. Two ¼-inch guide pins serve to hold the jaws in place when in use.

The second sketch shows a small arbor press for use on the bench. It is made from a bit of ½ by 1½-inch flat bar stock and an old discarded valve stem and yoke—the



Arbor Press for Use at Bench

larger the better. The yoke is mounted on the special legs and a hole bored in the bench of sufficient area to suit the arbors used. A couple of pieces of flat stock serve for parallels. Where the shop is shy on equipment, this home-made press will find favor. It saves many spoiled arbors, doing away with the old method of whanging 'em in with a copper maul. MACHINIST.

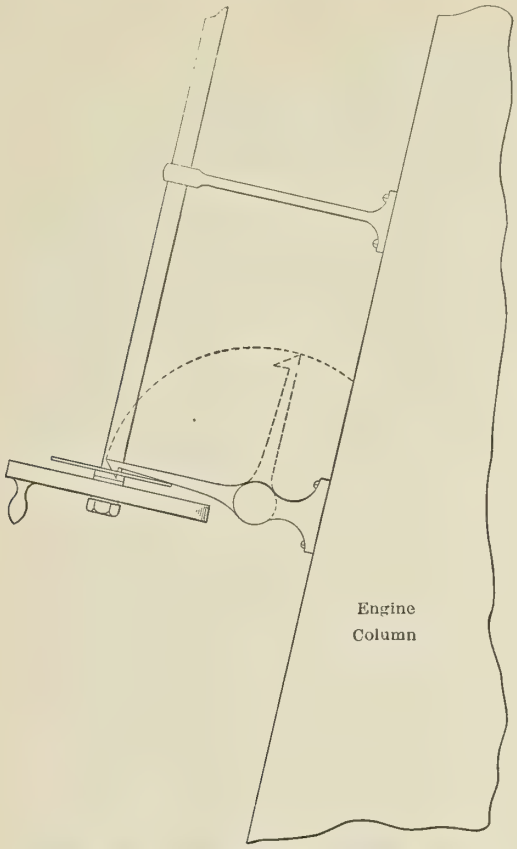
Device for Locking Engine Throttle Valve

Many marine engines have a long spindle attached to the stop valve for admitting steam to the engine, one end of which has a square socket which fits on a square on the valve spindle, with the other end terminating in a big handwheel near the starting platform, fixed at a convenient height for the engineer to open or shut, as desired. Very often, through vibration, the valve has a tendency to open up itself, and it is quite common to see this wheel tied with a piece of string after the engine is set at a certain speed and the necessary revolutions have been attained.

A very simple appliance was made by the writer to do

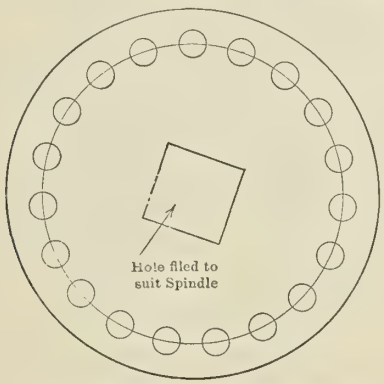
away with this tying-up process, and it is in operation now and giving every satisfaction.

Out of a piece of ⅛-inch brass I made a right-angle bracket, as shown, which I fastened to the column by two set-screws. Two cheeks were then made out of 1/16-inch brass and riveted on the bracket, which left ⅛ inch clear-



Drive for Locking Engine Throttle Valve

ance between the cheeks to allow the pawl to swivel round on the pin. The square on the spindle fitting into the handwheel was lengthened, and on this a circular brass plate was fitted. On this circular plate a pitch circle was drawn, and ¼-inch holes were drilled at ¾-inch pitch round the plate, as shown. An arm or pawl was made the required length to swivel round on the pin, being lightly riveted and sufficiently tight to remain in any position without dropping. When the arm was in position a sudden stop on the telegraph would not interfere with the rapid



Circular Plate for Locking Valve

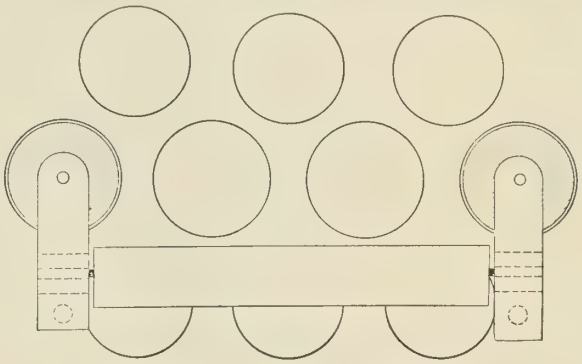
closing of the stop valve by the engineer; and in his haste to stop the engines as quickly as possible he would have no need to raise the pawl out of the hole, as the action of the wheel in closing the valve wedges the arm up clear of the hole.

When working engines into port the pawl can be raised to allow of the frequent opening and closing of the valve, as the appliance is intended only to keep the valve at a fixed opening to steam, once the necessary revolutions are attained. No particular dimensions can be given regarding the length of pawl, size of plate, etc., the reason being that no two ships are alike, and standardization in marine engines is only in the embryo. ENGINEER.

Saving Hose on Boiler Tube Cleaners

When cleaning boiler tubes with a water or air turbine cleaner it is necessary to insert and remove the hose supplying the air or water many times. Because of the rough nature of and sharp projections on some of the tube ends and sheets the hose soon wears through.

This wear and tear can be cut down considerably by using a roller device somewhat as shown in the sketch.



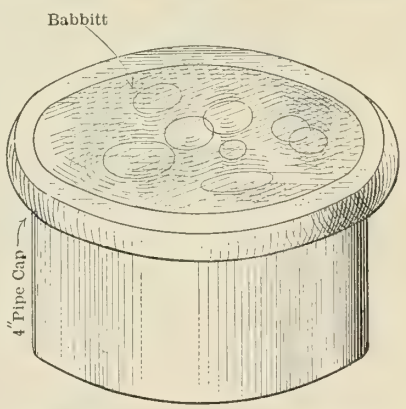
Roller Device for Saving Cleaner Hose

The roller can be made out of a piece of round wood rotating in two supporting brackets, which in turn are held against the boiler by two wooden pegs about 2 feet long, fitting into two of the boiler tubes. If the boiler construction precludes this design, the roller can be suspended from the ceiling by wires or from the floor on suitable standards.

Philadelphia, Pa. W. A. LAILER.

Gasket Punch Block

This is a quite simple kink, but worthy of space in any note book. A large size pipe cap is poured full of lead



Babbitt Filled Cap for Punch Block

and smooth, flush with the top, to give a soft cutting block on which to cut out gasket holes with the regular washer punch. The lead cannot spread or get all out of shape as it does when a piece of it is used alone on the bench.

C. H. WILLEY.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number of from examination for grade of chief, and by a dagger (†) if from examination for other grades.

How to Lay Out Shell Expansion Plan

Q. (990).—Will you kindly explain or show how the shell expansion drawing is laid out in the way of cants? I don't mean the laid-out plates as shown in the August issue, but merely a transverse expansion. I would also like to know how to get the true shape of the shell plates where they take transverse and longitudinal shape.

A. (990).—The shell expansion plan does not represent the correct shape of the various plates (except in the parallel middle body), due to the fact that no account can be taken of the longitudinal curvature. Its sole purpose is to indicate the position of the various plates, type of riveting, and the attachments of structure fastening to the shell plating.

One authority advises that the expansion of the shell in the way of the cant frames aft of the transom plate be obtained from the expansion of the actual plating at this point. This is not necessary, since no measurements are made by scaling the shell expansion. A convenient way of obtaining an approximation of the shell aft of the transom is to take a sheet of paper and place it on the plating model so that one edge coincides with the center line of counter. The position of the knuckle, rail, and cants can then be marked closely enough to transfer the same to the shell expansion plan.

In reply to your question as to the true shape or approximate development of shell plates having both transverse and fore and aft curvature, I would refer you to a very good article, entitled "Mold Loft Notes," by T. L. Cohee, in INTERNATIONAL MARINE ENGINEERING, 1917, p. 389.

Method of Installing Engine in Ship

Q. (989).—Can you give me a brief outline of the general practice of installing a main engine in a new ship? That is, getting the position of the bedplate, showing how the columns are mounted and the cylinders placed on them and how the lining up is done. I presume that everything is lined up from the tail shaft out to the engine and then the piston rods and guides, etc., are lined up by getting the center of each cylinder and gland and lining up with the crank on top and bottom centers, or as nearly as the wire will allow the crank to be turned. I do not expect you to go very deeply into this subject, but please give me just a brief outline of how this work should be done, so that I can follow your instructions.

A. (989).—It will be understood first of all that the engine has been previously lined up in the shop. If a planer large enough is available, the whole bedplate may be planed in one operation, viz., bearings, housings, and column seatings. If a suitable planer is not at hand the bedplate may be machined in sections, and the bearings bored out to give the proper alignment when tested by a taut steel wire. The bottom of the columns should be solidly bolted to the bedplate. Upon the tops of these the cylinders are clamped and adjusted until a piano wire stretched through the center of the stuffing box and center of the cylinder top intersects and is perpendicular to the wire through the center of the main bearings. After making sure that the center of the connecting rod will come half way between the bearings, the cylinders may be permanently bolted to the column tops. We may now proceed with the erection of the remainder of the engine.

Where there are crane facilities for handling the main engine, it is often installed without taking down any of the parts. With the vessel on the ways, the line of shafting from the center of the hole for the stern tube in the stern post to the boiler room bulkhead is found. If this length is short, a steel piano wire will be sufficient. If not, the more elaborate method of defining the center line of shafting by means of a ray of light and suitable shutters should be employed. All necessary holes in the stern post and bulkheads may now be bored, and the bearings for the line shafting fitted.

With the line and thrust shafting in place, all is ready for the installation of the main engine, which may now be lowered on its chocks or liners. By the use of a feeler gage between the engine coupling and the forward thrust shaft coupling, the main engine may be adjusted to give a constant clearance all around these couplings. This will insure that the engine shaft is in line.

Should the engine be installed in sections, the bedplate may be located so that the center of the main bearings will line up with a steel wire set to represent the center line of the shafting. The center line of the cylinders may now be tested with the main shafting in place (connecting rod, piston rod, piston, and cylinder cover removed) by stretching a wire through the center of the cylinder. With the crank as near the top center as the wire will allow, measure the distance from the wire to the crank web, turn the crank to the bottom center, and repeat this measurement. If these measurements are the same, the center line of the cylinder is perpendicular to the center line of the shafting.

Development of Longitudinals

Q. (986).—I am at present employed in the mold loft of a steel shipyard and am developing longitudinals. I would appreciate it very much if you would send me the most simple and practical method of the development of longitudinals in the Isherwood system of framing vessels.

A. (986).—Longitudinals are commonly run parallel to the decks on the side of ships and on the bottom parallel

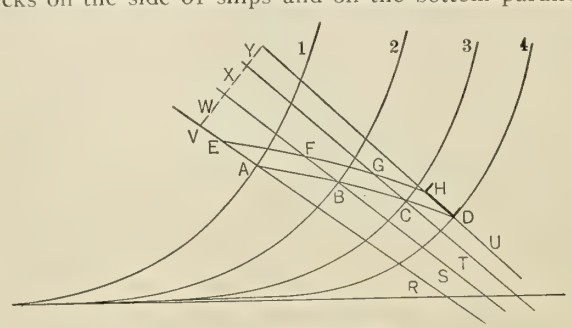


Fig. 1.—Portion of the Body Plan

to the keel. They are spaced two and one-half to three feet apart, and may run in one piece even to a length of 30 or 40 feet, being efficiently spliced at the joints and carefully bracketed to the bulkheads at either end. In oil tankers they stop, of course, at the bulkheads.

For the bottom longitudinals next the keel, buttock planes will give ready means of obtaining a template. The development of the longitudinals along the side is simple, since it is similar to that of the deck. Where the hull is of double curvature, this is not so easily done, and accuracy requires special care . The longitudinals are run as nearly normal as possible to the frame contour, and their position determines the best and simplest method of development.

The usual procedure is to consider that the longitudinal lies in a warped surface. Develop this surface and obtain the shape of the template for the longitudinal from that. In Fig. 1 we have a portion of the body plan in which *A, B, C, D* represents the heel of the longitudinal at stations 1, 2, 3 and 4; also *EA, FB,* etc., are the traces of the longitudinal. The first step consists in producing these traces. If the traces are nearly parallel, the development is not very difficult. Draw a line *VY* which will be a mean between the perpendiculars to the traces *EA* and *HD*. Draw *RU,* making *VR* equal to *YU*.

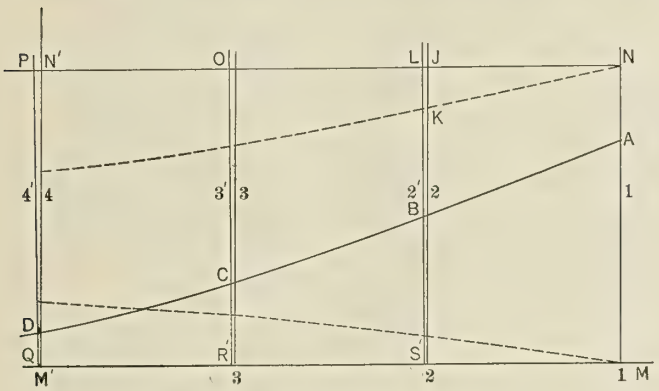


Fig. 2.—Diagram of Station Lines

In Fig. 2, lines 1, 2, 3, 4 represent the station lines. On station 1, lay off *MN* equal to *VR,* Fig. 1, and erect *MM'* and *NN'* perpendicular to *MN*. We must next allow for the fact that the station lines on the warped surface are farther apart than the actual station spacing, and are not likely to be parallel. On station line 2, lay off *JK* equal to *VW,* then *KN* will equal the distance from *N* to the station line 2, allowing for the curvature of the surface. Make *LN* equal to *KN*. Follow this procedure through, thus obtaining the points *L, O, P, Q, R, S,* Fig. 2. We may now draw the station lines *2'*, *3'* and *4'*. The figure *N L O P Q .. M,* Fig. 2, will closely approximate the development of the surface *V W X Y U . . . R,* Fig. 1.

Take *NA, LB, OC, PD,* Fig. 2, respectively equal to *VA, WB, XC, YD,* Fig. 1. If now line *A B C D* is drawn, we have the development of the longitudinal. A mold would be made to this curvature and given to the angle-smith. When the traces *EA, FB,* etc., of the longitudinal are not very nearly parallel the method of obtaining the position of the station lines is not so easy; triangulation may be then employed. Different loftsmen have approximate methods which will produce satisfactory results to anyone engaged in the work. The initial steps alone differ as a rule, and where caution is exercised one will not necessarily go far astray, provided, of course, some unusual features are not involved in the problem.

NEW BOOKS

United States Coast and Geodetic Survey issues new volume of "Coast Pilot."

There has just been issued by the U. S. Coast and Geodetic Survey a new volume entitled "The United States Coast Pilot, Atlantic Coast, Section B," covering the coast and interior waters from Cape Cod to Sandy Hook, including Nantucket Sound, Vineyard Sound, Buzzards Bay, Narragansett Bay, Long Island Sound and tributaries, and New York Harbor and tributaries.

This volume, which replaces a part of Coast Pilot Part III, and all of Coast Pilot Part IV, has been revised and brought up to date from new data collected in 1917. It contains descriptions of all navigable waters within its limits, with directions for navigating them; information concerning port facilities, where supplies can be had and where repairs can be made; tide and current information, and much other information usually contained in a coast pilot.

Programme of Annual Meeting of Society of Naval Architects and Marine Engineers

The twenty-sixth general meeting of the Society of Naval Architects and Marine Engineers will be held in Witherspoon Hall, Philadelphia, Pa., located at Walnut and Juniper streets, Thursday and Friday, November 14 and 15, and will begin at 9:30 A. M. each day.

The annual banquet will be in the Grand Ball Room of the Bellevue-Stratford at 7 P. M. Friday, November 15.

The Council will meet at 3 P. M. Wednesday, November 13, in the office of the secretary-treasurer, Daniel H. Cox, U. S. Shipping Board Building, 140 North Broad street, Philadelphia.

Thursday, November 14, 1918

1. "The Delamater Iron Works."
   By H. F. J. Porter.
2. "Revival of Wooden Shipbuilding as a War Emergency."
   By Carlos deZafra.
3. "Application of Buoyancy Boxes to Steamship *Lucia* for the United States Shipping Board."
   By W. T. Donnelly.
4. "Notes on Progress in Turbine Ship Propulsion."
   By Francis Hodgkinson.
5. "Notes on Launching."
   By William Gatewood.
6. "Side Launchings of Ships on the Great Lakes."
   By Frank E. Kirby and Edward Hopkins.
7. "Structural Steel Standardized Cargo Vessels."
   By Henry R. Sutphen.

Friday, November 15, 1918

8. "On Vibrations of Beams of Variable Cross Section."
   By N. W. Akimoff.
9. "Experiments Upon Simplified Forms of Ships."
   By Professor H. C. Sadler and T. Yamamato.
10. "Variation of Shaft Horsepower, Propeller Revolutions and Propulsive Coefficient With Longitudinal Position of the Parallel Middle Body in a Single-Screw Cargo Ship."
    By Commander Wm. McEntee, Naval Constructor, U. S. Navy.
11. "Recent Developments in Shipyard Plants."
    By Commander Sidney M. Henry, Naval Constructor, U. S. Navy.
12. "Present Status of the Concrete Ship."
    By R. J. Wig.
13. "The Application of Electric Welding to Ship Construction."
    By H. Jasper Cox.
14. "Hog Island—The Greatest Shipyard in the World."
    By W. H. Blood, Jr.

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

NEW SHIPYARDS AND EXTENSIONS OF EXISTING YARDS

Additions, Improvements and Orders for New Equipment

The Medomak Shipbuilding Company has been organized at Waldoboro, Me., with Capt. Willard F. Wade as president; Arthur E. Lord, of Lynn, vice-president; Josiah Grossman, of Lynn, treasurer, and John V. Poland, Quincy, Mass., general manager.

The St. Petersburg Maritime & Construction Company has been organized at St. Petersburg, Fla., with L. B. Brown, president; W. H. Franklin, vice-president, and F. Francke, secretary.

The Astilleros de Tarragona, S. A., has been organized at Tarragona, Spain. It is stated that there will be four berths in this yard.

The Dawn Boat & Shipbuilding Corporation has been incorporated by E. Hehre, J. W. Becherer and G. Auer, 912 Forest avenue, New York.

The Brude Line Boat Company has been incorporated by A. Johannessen and H. Gunderud, 3089 Broadway, New York.

The Marine Corporation has been incorporated at Los Angeles, Cal., by W. P. Winston, R. B. Aitchison and James R. Williams.

Louis B. Harrison Shipyard Company has been incorporated at Athens, N. Y., by J. F. McKinney, L. B. Harrison and M. H. Reiss.

The United States Navy Department, Washington, D. C., is planning to build a large dry dock and ship repair works at Stapleton, S. I., on property belonging to I. T. Williams & Sons. The Navy Department has also taken over the plant of the Merritt & Chapman Derrick & Wrecking Company, in the same district, to be used for the same purpose.

The Marine Works has been incorporated by H. Kaplan and H. Barrow, 59 East 118th street, New York.

The Gray Haven Shipbuilding Company has been organized at Detroit, Mich., and will build concrete barges for the New York State barge canal.

The Manistee Shipyard Company, Manistee, Mich., will soon begin work on barges for the New York ship canal.

The Victor Barge Corporation has been incorporated by M. C. Sullivan, J. C. Duke and B. B. Mead, 1999 Washington avenue, New York.

The Watercraft Construction Company has leased from the Degnon Realty & Terminal Improvement Company, 68 Hunters Point avenue, Long Island City, a tract of land on Flushing Bay, where they are planning to build a plant for the construction of wooden barges.

The Bruce Dry Dock Company, Pensacola, Fla., is planning to build a new dry dock.

The Fabricated Ship Corporation has been organized at Milwaukee, capitalized at $600,000. Already the Government has awarded contracts for thirteen steel ships, most of which will be 172 feet long and 32 feet beam.

A new shipbuilding company, to be known as the North Country Shipbuilding Corporation, has been incorporated, with a capital stock of $150,000. The yards will be at Ogdensburg, N. Y.

The New Bedford Dry Dock Company, Stonington, Conn., has been incorporated by Mark L. Gilbert, Mystic, Conn., and others.

The Ambursen Construction Company has commenced operations at its new shipyard at Little Ferry, near Hackensack, N. J., for the construction of a number of concrete boats for the Government. Headquarters of the company are located at 61 Broadway, New York.

The New York Shipbuilding Company, Camden, N. J., is rapidly completing its new shipyard along the Delaware River front. The cost of the new plant, which is being built in co-operation wtih the United States Shipping Board, is estimated at around $10,000,000.

The Mobile Shipbuilding Corporation, Mobile, Ala., to secure materials for the construction of steel vessels at its plant, has commenced the construction of a new steel fabricating works on Fifth avenue, Birmingham, Ala., under the name of the Birmingham Steel Corporation, with Henry Leon Brittain as president of both organizations.

The Milliken Bros. Manufacturing Company, Inc., following the occupancy of the former plant of Milliken Bros., Inc., Milliken, Staten Island, N. Y., by the Downey Shipbuilding Corporation, has been formed to take over certain assets of the former company and continue its name. C. T. Clack, for many years connected with the United States Steel Corporation, has been made president; J. E. Jennings, vice-president and secretary; Robert Grant, treasurer. Offices have been established in the Woolworth building, New York.

The consolidation of the Luckenbach Company, Inc., and the Luckenbach Steamship Company, Inc., was recently consummated at a special meeting of the shareholders. The two companies are now united under the name of the Luckenbach Steamship Company, Inc. The consolidation has only a formal significance and involves no change in the practical conduct of the company.

Navy Yard Contract Let

The Department of Labor authorizes the following:

A contract for siding and excavation at project No. 27 A. B. and C. Washington Navy Yard has been awarded to R. G. Colins, Munsey Building, Baltimore, Md.

PROGRAMMES FOR SHIPBUILDING IN FOREIGN NATIONS

Australia's Ship Plans Extensive

Details of Australia's shipbuilding programme show that two Isherwood standardized steel ships, each of 5,500 tons, are being constructed at the Williamstown Shipbuilding Yards, and six others are to be subsequently built there. Delay has been caused by the late arrival of shipbuilding material from America. Six similar standardized vessels are being built at Walsh Island, Newcastle; two at Cockatoo Island dockyards, Sydney; two at Devonport (Tasmania).

Two contracts for the construction by private firms in Australia of wooden ships, to be fitted with auxiliary engines, have been completed, one for six ships of 2,300 tons, and the other for six of 2,600 tons.

A definite proposition has now been submitted to the Commonwealth Government for the construction of six wooden vessels in Western Australia.

The ships under construction in the United States on account of the Commonwealth Government comprise 14 vessels, four first-class wooden cargo motor ships, of about 3,200 tons capacity deadweight, and ten first-class wooden cargo steamers (twin-screw). The four motor ships are being built at Olympia (Washington) by the Sloan Shipyards Corporation. The ten steamers are being built by the Patterson Macdonald Shipbuilding Company, at their yards at Seattle, Washington.

Italy Using All Available Ways

Italy is anticipating developments after the war. The "Cunard Line" of Italy, the Navigazione Generale, has increased its capital over 10 percent. This increase will be utilized in part for the extension of shipbuilding operations in the Cantieri Cerusa near Genoa and in the Cantieri Meridionale, Naples. In 1917 fourteen new Italian shipping companies were established and nine new shipyards. Nine old yards whose equipment has been considerably extended during the war are able to lay down at the same time 20 steamers of 8,000 gross tons and ten steamers of 5,000 tons each. Of the new shipyards only four are at present available. These could accommodate eight steamers, three of 8,000 tons and five of 5,000 tons each.

French Shipbuilding Programme

The new shipbuilding programme made public on October 9 by Fernand Bouislon, Under-Secretary of State of the Merchant Marine, includes vessels to be built representing a 1,500,000 tonnage.

Marine Internal Combustion Industries Organize for War Service

A War Service Committee has been appointed to work specifically in the interests of the marine internal combustion engine industry of this country before the War Industries Board and other branches of our Government.

The following representative manufacturers will serve on this committee:

Eugene A. Riotte (chairman), Standard Motor Construction Company, Jersey City, N. J.;

James Craig, James Craig Engine & Machine Works, Jersey City, N. J.

Charles A. Criqui, Sterling Engine Company, Buffalo, N. Y.

Ora J. Mulford, Gray Motor Company, Detroit, Mich.

Charles W. Pank, Fairbanks, Morse & Company, Chicago, Ill.

Richard R. Young, Union Gas Engine Company, San Francisco, Cal.

Mr. Seymour, McIntosh & Seymour Corporation, Auburn, N. Y., whose name was presented and favorably acted upon, was unable to be present at this meeting and has since notified the committee that, much to his regret, it will be impossible for him to serve owing to illness.

The committee is in touch with the Automotive Products Section of the War Industries Board and with the Statistical and Conservation committees with regard to certain conditions that must be met before the War Service Committee can properly prepare to take up the work in detail. The filing of a questionnaire by every engine builder of repute in this country is the first step. This questionnaire will be along the lines of those required of other industries by the War Industries Board, and in view of the nature of some of the information asked will be strictly confidential. When properly filled out questionnaires should be returned at once to the office of the War Service Committee, 29 West 39th street, New York City, from whence they will, when all have been collected, be turned over to the War Industries Board.

Seattle Shipbuilding Industry

Wages disbursed to the Seattle shipyards aggregate about $3,100,000 per month. The number of workers employed in shipyards and repair plants now total 27,400. The United States Shipping Board has awarded to one company contracts aggregated $100,000,000 of new ships, in addition to Government contracts previously issued. Contracts for fourteen steel freighters of 8,800 tons each have been awarded to another company; and five additional 8,800-ton steel freighters to a third company at a price estimated at $9,000,000. The following is a list of steel vessels contracted to be built in Seattle before the expiration of 1919; (1) 65 ships, 62 of which are 8,800 tons, and 3 of 7,500 tons, a total of 568,100 tons; (2) 24 ships, 22 of 8,800 tons, and 2 of 10,800 tons, a total of 213,600 tons; (3) 19 ships of 8,800 tons, totaling 167,200 tons; (4) 8 ships of 9,500 tons, totaling 76,000 tons; making a grand total of 1,024,900 tons.

Three Dry Docks for Philadelphia

The establishment of three dry docks at Philadelphia has been recommended to the American Shipping Board by the Commission on Port and Harbor Facilities. As a result of a meeting of the shipbuilding interests it was decided to recommend the type known as the "graving" dock, and that one of these, not less than 900 feet nor more than 1,000 feet, be constructed at Petty's Island; that one of 625 feet be built at Chester, and that the third be built either on the Philadelphia side of the Delaware River or on the New Jersey shore, or a moderate-sized dock on Petty's Island.

Over Thirty Million in New Ship Firms

Twenty-one new ship firms were organized during the month of September, with an authorized capital stock of $30,879,000. This brings the grand total for the entire war period up to $484,283,000. Of the September total $5,250,000 went into the actual building of ships, while $25,629,000 was the amount devoted to the operation of vessels. The development that has taken place in the shipbuilding industry in the United States is shown in the following table, which sets forth the authorized capital of new concerns:

Five months, 1914	$1,844,000
Year 1915	37,662,000
Year 1916	69,466,000
Year 1917	271,503,000
Nine months, 1918	106,758,000

To Combine Shipbuilding and Ship Operation

The Merchants Shipbuilding Company, of Bristol, Pa., headed by W. A. Harriman, has organized an operating complement to be known as the Independent Steamship Corporation, of which Mr. Harriman is to be the president. The new corporation will open offices at 69 Hanover street, New York. Several steamships have already been allotted to it by the Shipping Board. A combined shipbuilding and ship operating enterprise, one of the first of its kind, is thus formed. The precedent may be followed by other large shipbuilding concerns.

Hong Kong Shipping

The United States Consul-General at Hong Kong states that while the demands of the war have led to a constant and continued withdrawal of ships serving Hong Kong, particularly of British ships in the Australian, Philippine and coastal services, these withdrawals have been carefully made, and by taking over the control of practically all British ships on these runs the British Government has eliminated loss of space and waste in service, and managed so that the Colony's commerce suffered comparatively little from the restrictions.

In the transpacific routes few withdrawals for Government service elsewhere were made, but the governments concerned took over large cargo space and passenger accommodation on Pacific steamers for their own purposes. Early in the year the Japanese Government also took certain vessels of the Nippon Yusen Kaisha and the Osaka Shosen Kaisha, then in the Hong Kong Pacific coast service, thus withdrawing considerable steerage passenger accommodation from the market in Hong Kong.

Recent Shipbuilding Contracts Awarded

The Northwest Steel Company, Portland, Ore., has received a contract from the United States Shipping Board, Emergency Fleet Corporation, Washington, D. C., to build ten more 8,800-ton steel steamships.

The Toronto Shipbuilding Company, Toronto, Can., John E. Russell, general manager, has received a contract to build ten wooden steamships for the French Government.

The Albina Engine & Machine Works, Portland, Ore., has received a contract from the Emergency Fleet Corporation to build four more 8,800-ton steel steamships.

The Leatham D. Smith Shipbuilding Company, Sturgeon Bay, Wis., has received a contract from the United States Navy Department to build twelve wooden tugs, each 100 feet long.

The Elliott Bay Shipbuilding Company, Seattle, Wash., has received a contract from the Emergency Fleet Corporation to build five 3,500-ton wooden steamships.

The Northwest Engineering Works, Green Bay, Wis., has received a contract from the United States Navy Department to build thirty-four ocean-going tugboats.

New Contracts for Wooden Cargo Vessels

The Shipping Board announces that during the week of August 3 contracts for eighteen wooden cargo vessels and sixteen wooden barges were let.

Fourteen vessels of 3,500 tons each will be built as follows: Wright Shipyard, Tacoma, Wash., 2; the Midland Bridge Company, Houston, Tex., 8; John H. Fahey, Jacksonville, Fla., 4.

Four ships of 4,500 tons each will be built by Kiernan & Kern, Portland, Ore.

Ten barges will be built by the Midland Bridge Company, and 6 by John H. Fahey.

Boom in British Concrete Construction

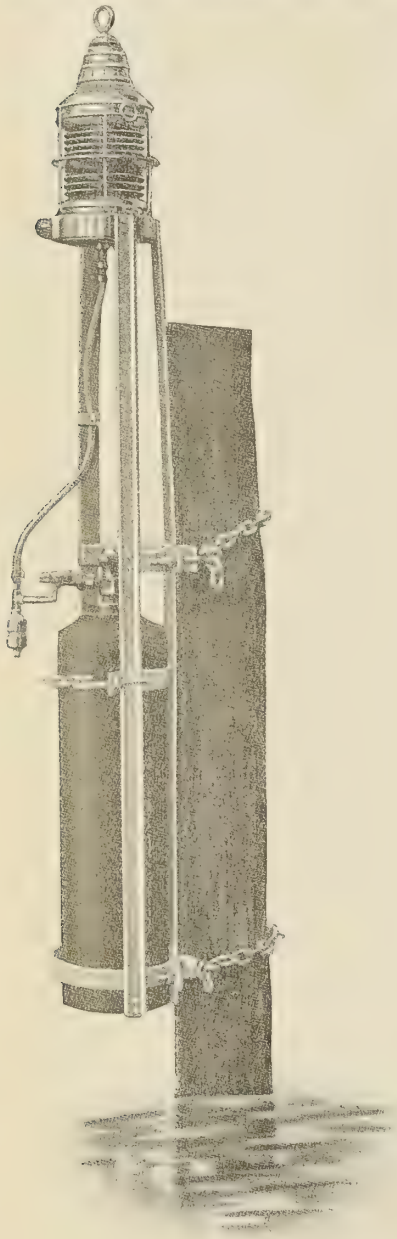
The yards in which reinforced-concrete ships and barges are being built are multiplying in the British Isles. Some 220 vessels are in course of construction. These represent a total of about 200,000 tons of shipping and a capital outlay estimated at nearly £4,000,000, apart from the cost of the land and the shipyard plants. On the designs adopted the saving of steel is about 70,000 tons.

The British Admiralty gives every encouragement to the private firms undertaking this new industry. Several vessels of 1,000 tons deadweight carrying capacity are already on the point of completion.

The vessels at present in course of construction for the Controller-General of Merchant Shipbuilding comprise barges of 1,000 tons deadweight carrying capacity and steam tugs of 750 h. p. In addition, six cargo steamships of 1,150 tons deadweight are being built for private ownership, and designs have been prepared for steamships of much larger size, which it is understood will be constructed after the pressing needs of the Government for smaller craft have been sufficiently met.

Long-Burning Acetylene Marine Beacon

The war necessity for rapid loading of vessels by night and day and for brilliant lighting at all times has led to the development of new types of marine lamps. The Milburn marine beacon, a fixed acetylene gas light which will burn continuously for a number of days without attention, represents one of the newest designs. This beacon, built by the Alexander Milburn Company, Baltimore, Md., consists of a storm-proof marine lamp with a Fresnel lens supplied with gas from a steel storage tank, which is



Acetylene Marine Beacon

held in a strong steel frame firmly attached to pole, pile or buoy. As designed, the burner gives a long, pencil-like flame within the lens, the rays of which are concentrated horizontally, so as to be visible up to a distance of five miles or more, according to requirements. These beacons are made in any size and candle power for any burning period. Arrangements are made for recharging the gas cylinders, used so that the cost of gas consumed is the only expense connected with the upkeep of the beacon.

The frame is made of rigid steel channel bars and steel bands securely riveted together and galvanized. Steel grips at the back of the frame, with heavy adjustable chain loops, secure a tight hold, regardless of variation in pole diameter.

Since these lamps are often installed in the open water, and all adjustment must be made from a rocking rowboat, the ease with which parts may be replaced and the lamp adjusted becomes an important factor. The flexible metal-armored tube connection between tank and lantern permits coupling and uncoupling of gas connections without difficulty, and provides for the opening of the lantern bottom without disturbing the gas connection

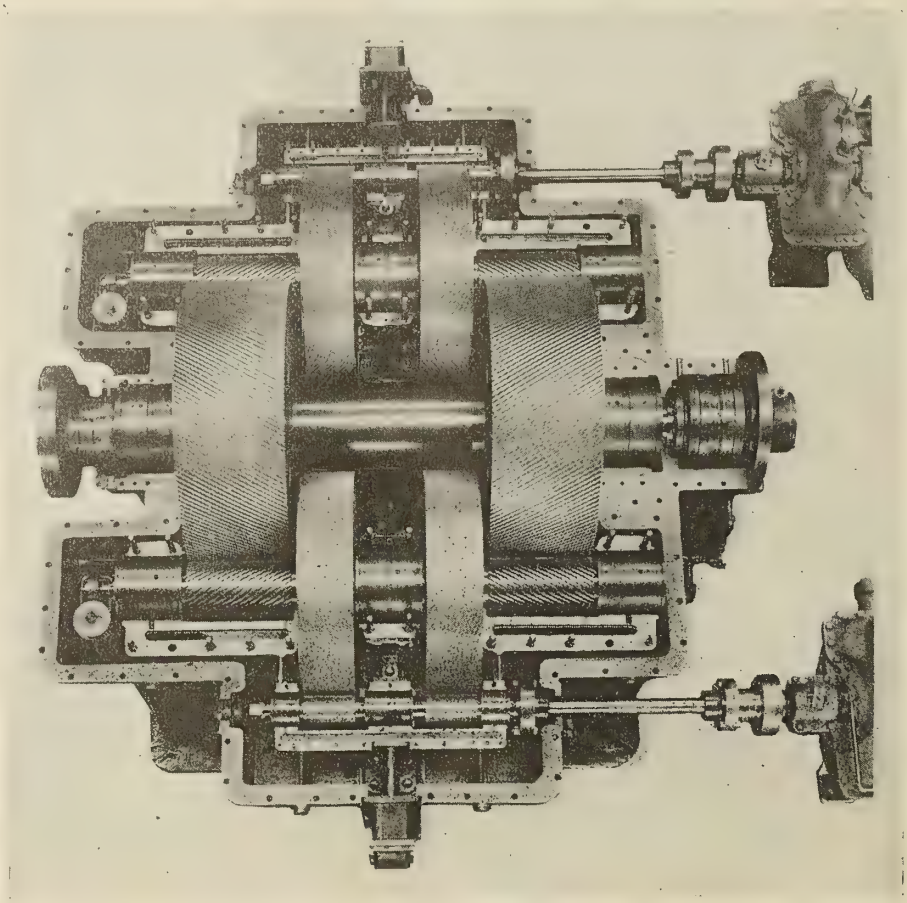
Floating Frame Reduction Gears for Ship Propulsion

The application of Westinghouse steam turbines with reduction gears of the floating frame type for ship propulsion is well carried out in the machinery of the tank and cargo steamers built and building at the yards of the Chester Shipbuilding Company, Chester, Pa., and other shipbuilding plants on both the Atlantic and Pacific seaboards.

Vessel Fitted with Westinghouse Floating Frame Reduction Gears

Geared turbine propelling machinery may be located in the stern of the vessel, as has been found expedient in the case of oil tankers, or its location may be amidships, which is usual for cargo ships.

As a typical example, in the case of a tanker, take the Malmanger (submarine), which was a vessel with the



Westinghouse Floating Frame Reduction Gears

principal dimensions listed as follows:

Length	401 feet
Beam	54 feet
Draft	25 feet 9 inches
Displacement	12,650 tons
Cargo capacity	9,000 tons
Speed	10.5 knots

The boilers and propelling machinery are located aft and comprise three single-ended Scotch boilers, a Westinghouse cross-compound turbine-unit, consisting of a high pressure turbine and a low pressure turbine, and two single-pinion first reduction gears, and one two-pinion second reduction gear. The arrangement is as follows:

Each turbine is coupled to one of the first reduction gears, which in turn are coupled to the second reduction gear, this latter gear being directly connected to the propeller shaft. By means of this arrangement of double reduction gears comparatively high speed turbines (3,600 r. p. m.) are utilized for driving a slow speed propeller (70 r. p. m.). The propeller thrust bearing is of the Kingsbury marine type and located at the forward end of the second reduction gear. The lubrication of the main turbine bearings, as well as the gear teeth and bearings, is effected by a continuous supply of oil through a gravity system. Two oil pumps driven off the gear shafts, a cooler, strainer and storage tank, also comprise part of the oil system.

The reduction gears are of the Westinghouse floating frame type. At the designed full power, the first or high-speed gears reduce speed from 3,600 to 450 r. p. m. and transmit 1,250 horsepower each. The second or low-speed gear reduces the speed from 450 to 70 r. p. m. Each pinion transmits 1,250 horsepower. The total speed reduction from the turbine speed of 3,600 r. p. m. to the propeller speed of 70 r. p. m. gives a ratio of 51.4 to 1. The gears are completely enclosed in an oil-tight cast iron gear housing, and are of double helical type, the teeth being inclined at an angle of 30 degrees. The teeth are of involute form and are cut with the utmost precision, to obtain reliable and quiet operation.

The pinions are of the three-bearing type and are carried in a floating frame, which automatically maintains the alignment of the pinion and gear under all conditions of load, thereby producing uniform distribution of the pressure over the entire length of tooth face. Each pinion is driven by a flexible shaft which extends through it and is secured to the end remote from endwise. The flexible shaft allows the pinion to adjust itself without restriction, to maintain its alignment with the gear wheel. The uniform distribution of pressure at all loads made possible by the use of the floating frame permits the use of the higher pressures and smaller pinions and gears than is the practice with reduction gears of the fixed bearing type.

The flexible frames are of rugged construction to avoid deflection, and are supported by feet under the middle bearing, this support being amply flexible to permit the required movement in a vertical plane. The ends of the floating frame are held in the correct vertical plane by horizontal struts. The frames are divided and bolted together horizontally, a longitudinal channel for supplying oil to the pinion bearings and teeth being formed in the joint.

The gear wheels are composed of a heavy forged steel shaft, a cast iron center and steel rims.

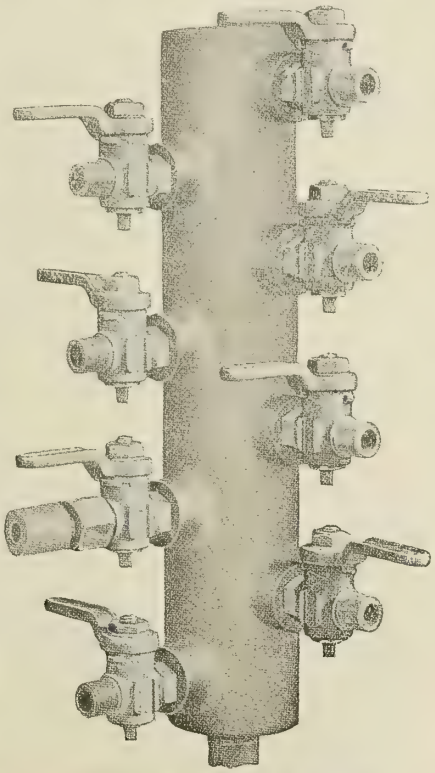
The gear and pinion bearings are composed of heavy cast iron bodies lined with genuine babbitt. The bearings are supplied with oil at a pressure of about 5 pounds per square inch, which is introduced at the sides. No oil piping is contained in the gear housing. A trough which is supplied with oil from the channel in the floating frame distributes the oil to the teeth from above, as shown. Oil is supplied to the teeth from below by sprays which are directed against the back of the pinion from the channel in the frame, the oil being carried around with the pinion and drawn into the meshing teeth.

The illustration shows a group of first and second reduction gears, as applied to geared turbine equipments for ships having their engine rooms located aft. With this arrangement the gears are placed forward of the turbines, and the intermediate shaft passes between the turbines, enabling the tail shaft to be drawn inboard for inspection without displacing any part of the turbines or reduction gears.

In the case of ships having engine room located amidships, the turbines are placed forward of the gears. The gearing for the two-speed reduction is contained in one housing.

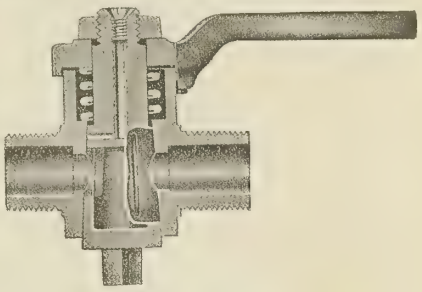
The Victory Lubricated Air Cock

Developed by engineers whose years of experience have brought them into contact with the many difficulties and requirements connected with compressed air service, and particularly pneumatic service in shipyards, with full knowledge of the extreme hard working conditions and the terrific strain that would be placed on every part of the plant, the Victory lubricating air cock was designed as a part of the special equipment for the air service lines of the largest shipbuilding plant in the world.



Victory Cock in Use in Manifold

This cock, which is placed on the market by the Victory Equipment Corporation, equipment engineers, 75 State street, Boston, Mass., has an oil pocket in the spindle, with outlets so located that each time it is operated enough lubricant is passed into the two oil grooves on the inside of the body to prevent "freezing" or sticking. The stop plugs on body limit the handle to a quarter turn, preventing to a degree the scoring of body or spindle by any foreign matter that may lodge there. The large tension spring, which is a part of the Victory cock, will retain its properties, it is said, under severest use. The tension spring is so adjusted that the proper tension between the spindle and body is readily maintained.



Section of Victory Cock

The valve is adaptable to any pneumatic, oil, gas or low-pressure hydraulic service, and may be furnished with any type of connections desired. It is designed to be applied directly to the manifold pipe line or whatever fitting may be in use, thus obviating the necessity of additional nipples or connections.

An inspection of the valve will show that the body is of sturdy construction throughout; is compact, and the movable working parts are well protected by generous amounts of material around the sensitive portions. All parts are of extra heavy construction and are built to stand excessive strain and abuse.

As a means of shutting off and turning on the flow of air to a pneumatic tool, this valve is claimed by the manufacturers to be the most efficient on the market. It is the quickest in operation, it is said, and absolutely free from leakage troubles.

All cocks are tested before leaving the factory and are guaranteed to be airtight for hard shipyard service. They are made in all standard pipe sizes from ¼ inch to 3 inches.

The Theory of Graphite Lubrication

The theory of all lubrication is to keep two moving surfaces apart. In theory this is correct; in practice, however, any oil or grease will stand weight or stress up to a certain limit, but if unusual weight or stress is placed upon the machine the oil or grease will squeeze out from between the surfaces and allow the metals to touch.

Metals are never smooth. Under a microscope the most highly polished piece of metal resembles a nutmeg grater. There are little pin points sticking up between the pores in the metal, tool marks and other irregularities. When the oil or grease squeezes out these irregularities interlock. This is the cause

of friction. These little pin points also break off. This is termed wear. Tiny particles of metal get into the lubricant and, returning through the bearing parts, act as an abrasive.

It has been demonstrated, according to claims made by the Joseph Dixon Crucible Company, Jersey City, N. J., that the proper use of lubricating graphite entirely overcomes this wear, since it fills in the pores of the metal and places a veneer over the entire wearing surfaces. Contact then exists only between graphite-and-graphite and not metal-to-metal. Obviously, if metals do not rub together they cannot wear.

The Berg Concrete Surfacer

With the expansion of piers and the enlargement of dry docks upon concrete foundations, and the increased construction of concrete hulls, the development of the Berg rotary concrete surfacer is particularly opportune. This machine, especially constructed by the Elevator Supplies Company, Hoboken, New Jersey, is made for the rapid and economical removal of board marks, fins and other irregularities which remain after the forms are stripped. The surfacer may be fitted with a cutting or grinding attachment, according to the requirements of the work. These attachments are driven through a flexible shaft by an electric motor carried by the operator. The motor is of the universal type, suitable for both alternating or direct current.

Berg Concrete Planing Machine

The machine, which is ball-bearing throughout, is lubricated by one grease cup. This feeds the lubricant for the entire tool through the flexible shaft casing.

This ingenious tool is a splendid time and labor saver. After the stripping is removed from the forms and the broken corners and other defects have been filled in by a cement and sand mixture, the wires and nails are then cut off at least one-half inch below the surface. The material is now ready for smoothing with the Berg surfacer with cutting tool attachment. This consists essentially of a disk in which sixteen hardened steel cutter wheels are mounted. The wheels roll on the surface to be dressed, and are so designed that their teeth remove the material by a chipping action. The teeth, in effect, are tiny hammers which strike several million blows per minute, producing a surface which forms a good bond float or other finishes.

To secure lasting results, the prepared area is then thoroughly wetted down and a mixture of 1:2 cement and white screened sand, reduced by water to the consistency of thick paint, is then swabbed on in small patches. While it it still wet, the mixture is rubbed in with the stone grinding attachment. During the process it is advisable to keep the mixture sufficiently plastic by frequent moistening with water. The action of the stone, which rotates at high speed, has the effect of grinding up the plastic material and forcing the finely ground mixture into the pores. Further grinding removes the surplus and produces a well-bonded, smooth surface that is impossible of production by hand.

The speed of this compact machine is quite phenomenal. It is claimed that in removing projectiles and fins only, it will prepare at least 100 square feet per hour. The aggregate may be exposed similarly to a brush-hammer and an excellent surface obtained on green work, at the rate of 60 feet per hour. Special finishing on the inside corners of fillets, beams, and other parts is possible with the grinding attachment, which produces 35 to 50 feet of finished surface per hour.

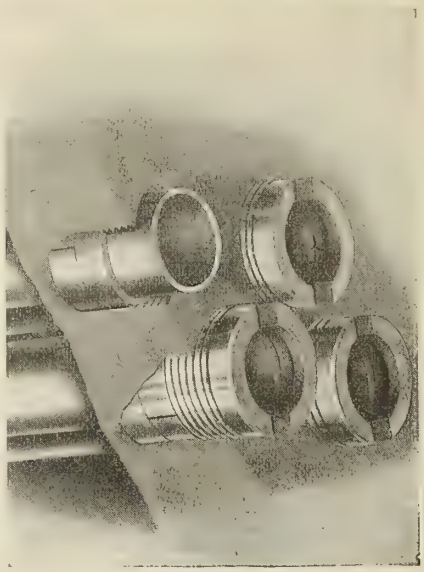
With labor and time at a premium, the need of a "speeding-up" machine is evident. The Berg surfacer supplies an integral link in the efficient chains which is rapidly being welded, it would appear.

Soft Flexible Metallic Packing for Condensers

It is now announced by The Crane Packing Company, 9 South Clinton Street, Chicago, after several years' actual use, that they have found "John Crane" Soft Flexible Metallic Packing to be an excellent packing for use in condensers.

The advantages of this packing in condensers are that it is permanent; fills crevices so completely that leakage is impossible; saves labor; and in the end is by far the most economical packing. Since the efficiency of steam turbines and condensing engines is dependent upon high vacuum, and since 12,000 tube condensers are not unusual these days, it is evident that the 24,000 tube packings in such condensers must be as good as human ingenuity can make them. They must prevent leaks dependably and permanently.

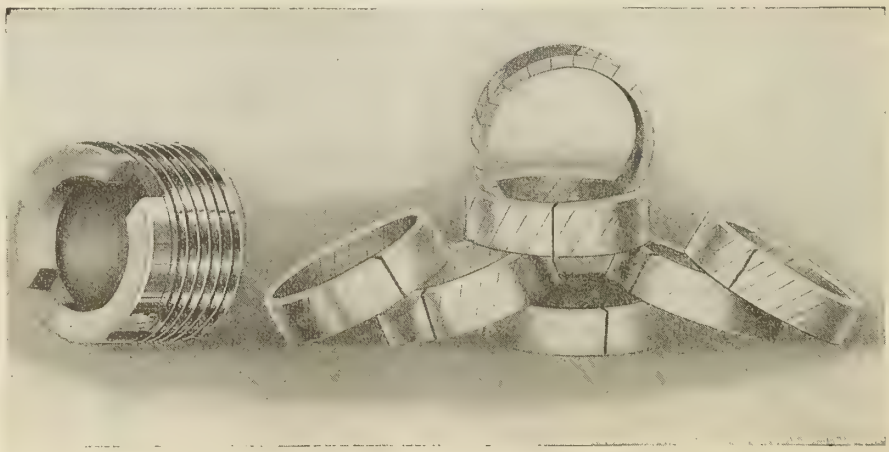
Cotton wicking, corset lacing, and fibre rings are not satisfactory, because they are not permanent. They eventually deteriorate under the action of steam, water, air, oil and heat. Sometimes these packings become hard or cement themselves into the tubes, causing the tubes to buckle. At best they are only temporary.



"Crane" Packing in Service

"John Crane" Soft Flexible Metallic Condenser Tube Packing is made of thin babbitt sheets, wrapped round and round spirally, lubricated between every layer and die-formed into rings, and as the result of this produces a ring of exact size and removes all guesswork as to uniformity. The simplicity of installation is apparent. This pliable metallic material under pressure of the gland completely seals the tube, yet allows freedom for the tube to slide. There is no expansion or contraction, nor yet excessive binding. A tube can be removed without disturbing the packing, and the same packing may be used for sealing a new tube. Also, the packing centralizes the tube. To insure against further leaks two or three rings, with joints staggered, are usually placed in each stuffing box.

This packing has another important advantage in that it is all-metallic and resists alkali, acids, salts, and such chemicals in solution. That pure circulating



Parts of "Crane" Flexible Metallic Packing

water is seldom found in central stations, water works plants, large industrial plants, is well known. In marine service the salt water circulating through condensers ruins any kind of fibre packing in a very short time, and when the sea water gets into the steam space of a condenser it is a serious thing. Chemicals and other foreign matter in sea water have been a source of great annoyance on board ship.

The entire elimination of these troubles when condensers and evaporators are equipped with "John Crane" Soft, Flexible Metallic Packing is the reason why marine engineers, as well as power plants engineers, should be interested in this new packing. A permanent leakless condenser tube packing is a great asset to any vessel at sea.

"John Crane" rings are just as flexible and pliable after years of installation as when they are new. They can be kept in stock indefinitely without deteriorating in the least.

The illustration shows how this packing is put in place in the stuffing box. Examination of this illustration will reveal that much time is saved in packing the tubes because of the fact that it is merely necessary to put in the ready-made ring and screw in the gland, as indicated. Fitting, trying, removing portions, cutting off and the like, all are eliminated.

The packing has already been given a thorough tryout on land and sea. Users state that after two years of uninterrupted service in large condensers maintaining the highest vacuums not so much as a sign of a leak has developed. It is prophesied by the engineers in charge that this packing will last as long as the condensers.

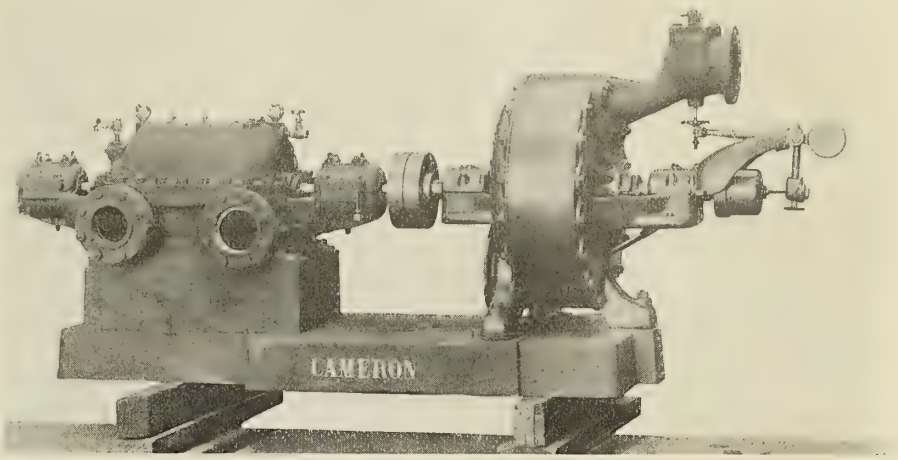
In ordering this packing it is obvious that the more information the manufacturer is given, the better. The outside diameter of the condenser tube should be given, and the inside diameter and depth of the stuffing box, the make of the condenser, the vacuum carried, the number of condenser tubes to each unit, and whether or not the stuffing box has a smooth bore. A rough sketch showing the stuffing box will assist both the user and the manufacturers.

This packing, it might be stated, is equally valuable on evaporators and heaters, and is now being used for packing practically everything in power plants and on ships, from valve stems to the largest plungers, and on service ranging from plain, pure water to concentrated acids.

Improved Centrifugal Pump

The development of the steam turbine and of the high efficiency multi-stage centrifugal pump have gone hand in hand. Up to the present, it has not been entirely practicable to reconcile the speeds of the two machines so that each would work at its best efficiency. It has always been necessary, heretofore, either to reduce the speed of the turbine and sacrifice much of its efficiency, or else speed up the pump with similar results. To overcome this difficulty a new type of multi-stage centrifugal pump has been designed by the Cameron Pump Works, 11 Broadway, New York.

The illustration shows this pump entirely assembled. The high speed feature is a virtue of the special impeller design. With the ordinary impeller the diameter cannot be reduced sufficiently to get high speed without sacrificing vane length, and consequently efficiency, since a certain vane length is very necessary in order that the impeller perform its function without excessive loss. Small external diameter and adequate vane length are obtained in this pump by bringing the vanes well down into the impeller hub. At the same time they are turned so that the incoming water is guided smoothly, and with little loss, into the outer portion of the vane. Here the velocity is generated that is finally converted into useful pressure by means of the external diffusion vane.



Three-Stage Type "BT" Boiler Feed Pump

Certain details in construction may be noted. The casing is divided along the horizontal outer line. Suction and discharge connections are in the lower half. The upper half is removable, giving access to the revolving element Suitable openings are supplied for draining the pump and displacing the air when starting. Inlet and outlet nozzles can be arranged on the same or on opposite sides —an advantage where pumps are installed in limited space. The shaft is made of high-grade forged steel accurately machined and ground. Contact with the fluid being pumped, is eliminated by the use of bronze sleeves, which prevent the stuffing box packing from scoring the surface of the shaft.

Each impeller, cast in one piece, is of the enclosed type. A pair of rings—one stationary, attached to the casing, the other revolving, attached to the impeller —surrounds each impeller hub. By the use of double rings the initial tightness of the joint between the low and high pressure sides of each stage is restored without fitting. The diffusion ring surrounds the impeller at its periphery, although not in contact with it. This ring contains a series of openings, which receive the water from the impellers at high velocity, reduce this velocity into pressure and enable it to advance to the entrance of the next impeller. If the high velocity of ejection were maintained a greater loss of energy would result.

This pump is equipped with a simple internal hydraulic balancing device to take care of thrust. This device consists of a revolving disk attached to the shaft at the inboard or high pressure end. Opposite this disk is a stationary drum of the same diameter. Water at high pressure connects with the space between the disk and the drum, causing the disk to react against the opposing thrust, neutralizing it and holding the rotor in proper relation to the casing. The slight leakage involved in this process is piped back to the suction. One ring-oiled bearing, self-aligning, is located on each side of the casing of the pump. The bearing bodies are horizontally split, with removable caps. The bushings, also split, are lined with high grade bearing metal. Bushings and bearing bodies have a spherical fit, automatically maintaining the alignment of the shaft. The bearings are supported by strongly ribbed brackets, cast integral with the lower casing, thus counteracting any possible tendency toward vibration. These brackets are located sufficiently distant from the stuffing boxes to permit of adjustment of the glands. Felt washers are provided to prevent oil escaping from the bearings. The deep stuffing boxes are provided with water seals, consisting of a lantern gland in each box. By a concealed passage, so arranged that it can be readily cleaned, this gland connects with the water from the discharged side of the pump. The gland is fitted with swing bolts to give quick and easy access to the stuffing box.

When the pump is direct-connected, it is supplied with a shaft coupling of the flexible type to compensate for slight variation in alignment. As may be noted from the illustration, the bedplate under the pump is of one-piece box construction, heavy enough to give a rigid support, and with cross ribs to prevent distortion. The manufacturers believe that this pump occupies less space than the ordinary boiler feed pump of this general type, and that it will give a much higher degree of efficiency.

Seized Shipyard Lays Keel

A German-owned shipyard in the United States has laid down its first keel for the new American merchant marine. The event took place at St. Andrews Bay, Millville, Fla. The company, known as the American Lumber Company, has been taken over by Alien Property Custodian A. Mitchell Palmer, and is now under American management.

Albert E. Eledredge has been appointed treasurer of the George Lawley & Son Corporation, Neponset, Mass.

Fusible Plugs Approved

During the month of July, 1918, the following list of fusible plugs was approved:

American Injector Company, Detroit, Mich.; heat 45.

Crane Company, Bridgeport, Conn.; heats 116 and 117.

Detroit Lubricator Company, Detroit, Mich.; heats 94 and 95.

W. T. Garratt & Company, San Francisco, Cal.; heats 94, 95 and 96.

Glasgow Iron Works & Supply Company, New York, N. Y.; heat 80.

Marine Manufacturing & Supply Company, Pittsburgh, Pa.; heat 16.

Point Pleasant Machine Works, Point Pleasant, W. Va.; heat 55.

Richards Iron Works, Manitowoc, Wis.; heat 10.

Southern Pacific Company, New York, N. Y.; heat 58.

Vulcan Iron Works, Cairo, Ill.; heat 15.

PERSONAL

Rear Admiral Wilson, who is now in command of the United States naval forces operating in French waters, has been designated to succeed Vice-Admiral De Witt Coffman in command of Battleship Force 2, Atlantic Fleet.

James A. Farrell, president of the United States Steel Corporation, has been offered the position of Director of Operations of the Shipping Board. Edward F. Carey, the present Director of Operations, was recently made chairman of the Board's Port Improvement Committee in charge of reorganizing dock and harbor facilities throughout the country.

The introduction of the "Weiss type" of oil engine by the Weiss Engine Company again brings the career of its designer, Carl W. Weiss, member of the American Society of Mechanical Engineering, the French Legion of Honor and many technical associations to the front. In 1876, Mr. Weiss began experimental work in America with the Benton Manufacturing Company, New York. Press work at the Nassau & Bendit plant

Carl W. Weiss

engaged his attention in 1878. During the eighties his time was occupied in perfecting a mechanical register and adding machine for the Check and Adding Machine Company of New York, the patents of which were finally sold to the National Cash Register Company in 1889. During this period, also, he was engaged in designing caloric engines of both atmospheric and high pressure types and in building his first internal-combustion turbine type engine. In 1891 the Weiss four-cycle type of engine was introduced, followed, in 1894, by the two-cycle, known as the Mietz & Weiss oil engine—a practical surface-ignition medium compression unit. Since that time there have been manufactured and sold about 300,000 horsepower of these engines, designed and built under Mr. Weiss's supervision at the Mietz & Weiss plant. After three years of special laboratory work Mr. Weiss is again returning to the production field to supervise the building of the engine which bears his name.

Guy E. Tripp, formerly colonel, United States Army and Head of Production Division, has been made brigadier-general, United States Army, and has been placed in offices having charge of the production of ordnance material in their respective sections of the country. Previous to his connection with the Ordnance Department, General Trip was chairman of the board of directors of the Westinghouse Electric & Manufacturing Company, with headquarters in New York.

B. H. Tripp, special representative of the Chicago Pneumatic Tool Company on the Pacific Coast, has been appointed district manager of sales for the Pacific Coast territory, with headquarters at 627 Howard street, San Francisco, Cal. The Los Angeles branch of the company at 521 Title Insurance building will also come under Mr. Tripp's jurisdiction.

John Wilson, Seattle, Wash., has purchased the plant and land of the National Steel Construction Company, Seattle, Wash., where he will build steel tugs and ships up to 300 feet in length.

William Averill Harriman, chairman of the board of directors of the Merchants' Shipbuilding Corporation, 6 Hanover street, New York, is president of the newly organized Independent Steamship Corporation.

C. D. Morton has resigned his position as sales engineer for the Page Steel & Wire Company, to become a captain in the General Engineer Depot, United States Army, at Washington.

Charles E. Goodnow, formerly assistant sales manager of the electrical and special wire department of the American Steel & Wire Company, and more recently identified with building construction work in Washington and Brooklyn for the army and navy, is now with the Page Steel & Wire Company, 30 Church street, New York.

Sir Arthur Harris, since 1916 director of overseas transport for the Canadian Government, has been appointed director general of shipping for Canada by Sir Joseph MacLay, the British Shipping Controller.

George H. Waters, formerly president of George H. Waters Company, Mariners' Harbor, N. Y., has been appointed to the position of president of the Raritan Dry Dock Company, Perth Amboy, N. J.

John D. Garver, lieutenant in the navy, has been made instructor in the United States Naval Steam Engineering School, Hoboken, N. J.

Sherman L. Whipple, of Boston, who has accepted the position of general counsel of the Shipping Board Emergency Fleet Corporation, has established offices in Washington.

Major General George W. Goethals, who has been recently identified with ship engineering and shipping activities, has been made a member of the War Industries Board. He is assistant chief of the general staff and director of the Division of Purchase, Storage and Traffic.

OBITUARY

Theodore Benedict Johnson, president of the Johnson Lighterage & Towing Company and widely known in shipping circles, died on September 30, at the Ritz Carlton Hotel, from pneumonia, which developed from an attack of Spanish influenza.

The Shipping Control Committee recently appointed Mr. Johnson superintendent of lighters and barges at New York. He had been aiding the Government in dealing with the shipping situation here ever since the United States entered the war. In May, 1917, he turned his yacht *Seneca* over to the Government for the period of the war. Shortly before his death he had made arrangements for the inauguration of a service between New York and Lisbon.

On October 12, John P. Hopkins, chairman of the board of directors of the Pneumatic Tool Company, Chicago, Ill., and the largest stockholder in that company, died in Chicago of heart failure superinduced by an attack of influenza. In 1880, Mr. Hopkins began his business career as machinist with the Pullman Palace Cor Company, later he became partner in the firm of Secord & Hopkins, Pullman, Ill. In 1905 he became interested in the Pneumatic Tool Company. A national figure in politics, he served out the unexpired term of Carter H. Harrison, Sr., as Mayor of Chicago in 1893-1894, was several times chairman of the Democratic National Committee, and was secretary of the Illinois Council of Defense.

Hugh Vernon Ramsay, general superintendent of Pusey & Son's yards, in Wilmington, Del., and Gloucester, N. J., died at his home, in Gloucester on October 10, of pneumonia, following influenza. Mr. Ramsay was born in Summerside, Prince Edward Island, 43 years ago, and was the son of Hugh Ramsay.

Francis Norman, one of the widest known men in marine circles around New York, died September 27, 1918. He was a member of the Maritime Exchange of the port of New York, and for many years was superintendent of the Kerr Line of steamships. Captain Norman made his home on Stratford Road, Brooklyn.

Captain George P. McKay, Cleveland, Ohio, treasurer of the Lake Carriers Association, and one of the best known steamship men on the Great Lakes, died on August 5, aged eighty.

Henry G. Lytle, for thirty years cashier of Robins Dry Dock & Repair Company, Brooklyn, N. Y., died recently as a result of injuries in an automobile accident.

Captain David V. Woolsey, an old steamboat captain on the Hudson, died recently at Haverstraw, N. Y., aged eighty-two.